

# **EXHIBIT 17**

**UNITED STATES DISTRICT COURT  
NORTHERN DISTRICT OF CALIFORNIA  
SAN FRANCISCO DIVISION**

HUAWEI TECHNOLOGIES CO., LTD.,  
HUAWEI DEVICE USA, INC., and  
HUAWEI TECHNOLOGIES USA, INC.,

Plaintiff(s)/Counterclaim  
Defendants,

vs.

Samsung ELECTRONICS CO., LTD,  
Samsung ELECTRONICS AMERICA, INC.,

Defendants / Counterclaim-  
Plaintiffs,

and

Samsung RESEARCH AMERICA, INC.,

Defendant,

v.

HISILICON TECHNOLOGIES CO., LTD.,

Counterclaim-Defendant.

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Case Number: 3:16-cv-2787-WHO

**REBUTTAL EXPERT REPORT OF DR. ZHI DING**

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## **I. INTRODUCTION**

1. My name is Zhi Ding, and I have been retained as a technical expert by counsel for Plaintiffs Huawei Technologies Co. Ltd., Huawei Device USA Inc., Huawei Technologies USA Inc. and HiSilicon Technologies Co Ltd. (“Huawei”) (collectively “Plaintiffs”) to provide assistance in the above-captioned matter against Defendants Samsung Electronics Co., Ltd., Samsung Electronics America, Inc., and Samsung Research America, Inc. (“Samsung”) (collectively “Defendants”).

## **II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE**

2. I am presently serving as Professor in the Department of Electrical and Computer Engineering at University of California, Davis, California, a position I have held since my appointment on July 1, 2000. I am also a private technical consultant on various information system related technologies. I have more than three decades of research experience on a wide range of topics related to data communications and signal processing.

3. I received a Ph.D. in Electrical Engineering from Cornell University, New York (1990); a Master of Applied Science degree in Electrical Engineering from University of Toronto, Canada (1987); and a Bachelor’s degree in Wireless Engineering from Nanjing Institute of Technology (later renamed Southeast University), China (1982).

4. My professional responsibilities as a Professor at University of California, Davis, include classroom instruction on various topics of communications systems and signal analysis, as well as mentoring undergraduate students and supervising graduate students’ research and development efforts on various topics related to information systems, communications, and signal processing technologies. I have directly supervised basic research and development works ranging from signal detection to wireless networking. As the chief academic advisor, I have also directly

supervised the completion of more than 18 Master's theses and 25 Ph.D. dissertations on various topics related to digital communications. I have served full time as a faculty member at three major research universities in the United States over the past 28 years, including Auburn University from 1990 to 1998, University of Iowa from 1999 to 2000, and University of California, Davis, from 2000 to present.

5. Since 1990, I have served as the principal investigator of multiple highly competitive federal and local research grants, including sixteen major research projects supported by the National Science Foundation and two research projects funded by the U.S. Army Research Office. These competitive research projects focused on developing more efficient and effective digital communications transceivers, networks, and signal processing algorithms and tools. I have also participated in three large-scale projects supported by the Defense Advanced Research Projects Agency (DARPA) with teams of researchers. I have applied for, and received support from, other federal, state, and industry sponsors.

6. I have published over 170 peer-reviewed research articles in premier international journals, in addition to over 220 publications at top international conferences on communications and signal processing. I also authored two books on communications technologies. My most recent book, co-authored with B.P. Lathi, is entitled, "Modern Digital and Analog Communication Systems," 5th edition, and was published by the Oxford University Press in 2018. This previous edition of this book by the same authorship was widely adopted as an introductory textbook to communications systems.

7. I am a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), and was elected in January 2003 for contributions made in signal processing for communications. The IEEE is the world's largest professional society of engineers, with over 400,000 members in more

than 160 countries. The IEEE has led the development of many standards for modern digital communications and networking, most notably, the IEEE 802 series of WiFi network standards. The IEEE Grade of Fellow is conferred by the Boards of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year does not exceed one-tenth of one percent of the total voting Institute membership.

8. I have served the IEEE in the following capacities:

- Chief Information Office, IEEE Communications Society, 2018 — Present.
- General Chair of the 2016 IEEE International Conference on Acoustics, Speech, and Signal Processing, the flagship conference of the IEEE Signal Processing Society.
- Chair of the Steering Committee for the IEEE Transactions on Wireless Communications (2008-2010).
- Distinguished Lecturer of the IEEE Communications Society from January 2008 to December 2009.
- Technical Program Chair of the 2006 IEEE Globecom, one of two flagship annual IEEE Communication Society conferences.
- Distinguished Lecturer of the IEEE Circuits and Systems Society from 2004 to 2005.
- Associate Editor of the IEEE Transactions on Signal Processing from 1994 to 1997 and 2001 to 2004.
- Member of the IEEE Statistical Signal and Array Processing for Communications Technical Committee from 1993 to 1998.

- Member of the IEEE Signal Processing for Communications Technical Committee from 1998 to 2004.

9. In 2012, I received the annual Wireless Communications Technical Committee Recognition Award from the IEEE Communications Society, a peer award given to a person with a high degree of visibility and contribution in the field of “Wireless and Mobile Communications Theory, Systems, and Networks.”

10. I have also served as a technical consultant for the telecommunications industry. For example, in 1995, I consulted for Analog Devices, Inc., on the development of first generation DOCSIS cable network modems. I have also consulted for other companies, including Nortel Networks, NEC US Laboratories, and Futurewei. I worked as a visiting faculty research fellow at NASA Glenn Research Center in 1992 and at U.S. Air Force Wright Laboratory in 1993. I have served on multiple review panels of the National Science Foundation to evaluate competitive research proposals in the field of communications. I have also reviewed a large number of research proposals at the request of the National Science and Engineering Research Council (NSERC) of Canada as an expert panelist from 2010 to 2013, and also at the request of the Research Grant Council (RGC) of Hong Kong as an external reviewer.

11. I have served as expert witness or consulting expert on a number of matters related to intellectual property, especially in the arena of wireless communications, including cellular communications and Wi-Fi technologies in particular. From my prior experience, I have developed expertise in assessing the essentiality and technical value of patents, particularly with respect to the 2G, 3G, and 4G cellular standards and associated technologies such as Wi-Fi. For example, since 2007, I have been engaged in extensive expert work on various litigations involving patents alleged to be essential to cellular and Wi-Fi standards. In connection with my works on the present



litigation, I applied such knowledge and expertise when analyzing select patents, as described in further detail below.

12. A true and accurate copy of my curriculum vitae is attached as **Appendix A** to this report. My C.V. contains a list of major publications that I have authored in the previous 30 years. I am being compensated at my usual rate of \$615 per hour for my time spent on this matter. My compensation is in no way contingent on the content of my opinions expressed in this matter, or the outcome of this matter.

### **III. MATERIALS CONSIDERED IN FORMING MY OPINIONS**

13. Attached as **Appendix B** to this report is a list of materials that I have considered in reaching my opinion. In forming my opinions, I considered the materials cited in the expert report of Michael A.M. Davies (“Davies Rep.”), and the materials cited herein. I am prepared to use those materials, other materials that may be produced during the course of this proceeding, and supplemental charts and other demonstratives and representations based on those materials to support my testimony at trial.

### **IV. ASSIGNMENT AND SUMMARY OF OPINIONS**

14. I was asked to review and respond to the report of Michael A.M. Davies, an expert retained by Samsung. In particular, I was asked to review and respond to Mr. Davies’ opinions about non-infringing alternatives to certain Huawei patents. I was also asked to assess the similarities or differences between certain patents owned by Unwired Planet and the patents asserted by Samsung and Huawei in this case, in response to Mr. Davies’ opinions related to Unwired Planet patents.

15. Based on my analysis, I have concluded that Mr. Davies has not identified any viable non-infringing alternatives to the Huawei patents he evaluates.

16. Based on my analysis, I have also concluded that the patents owned by Unwired Planet identified by Mr. Davies are not technically comparable to the patents asserted by Huawei in this case. The Unwired Planet patents would have been seen as substantially different from the Huawei Patents from a technical perspective. I have further concluded that Mr. Davies has not identified a sufficient basis to establish that the Unwired Planet patents are technically comparable to the patents asserted by Samsung in this case.

**V. THE ABSENCE OF NON-INFRINGEMENT ALTERNATIVES TO CERTAIN HUAWEI PATENTS**

17. In this section, I review and respond to Mr. Davies’ opinions about non-infringing alternatives to certain Huawei patents.

**A. U.S. PATENT APPLICATION PUBLICATION NO. 2013/0028192 A1 (‘192)**

**1. SUMMARY OF THE ‘192 PATENT APPLICATION**

18. U.S. Patent Application Publication No. 2013/0028192 A1 (“the ‘192 Patent Application”), *Method, user equipment and base station for transmitting uplink control information*, with a priority date of April 7, 2010, granted as US Patent No. 8,797,967, is according to Mr. Davies the U.S. counterpart to patent CN201010146531 in the same patent family.<sup>1</sup> The applications are held by Huawei.

19. The ‘192 Patent Application discloses a novel method and apparatus (user equipment and base station) for transmitting Uplink Control Information (UCI) in a 4G LTE cellular system when carrier aggregation is used for enhanced connection speed.

20. More specifically, carrier aggregation (CA) allows the eNB and the UE to use the joint spectra of two or more component carriers (CCs) to provide larger transmission bandwidth.

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<sup>1</sup> Actually, Mr. Davies is mistaken. The U.S. counterpart to CN201010146531 is U.S. Patent No. 9,807,741.

Each activated downlink CC has its own unique UCI that must be transmitted by the user equipment to the eNB, including such control information such as Channel Quality Information (CQI), Precoding Matrix Indicator (PMI), scheduling request (SR) or Hybrid Automatic Repeat Request (HARQ) acknowledgement (ACK/NACK). One of the main problems in CA is the need for eNB to decode correctly UCI when the total number of bits in the UCI sent by the UE must include UCI for multiple activated CC. The pre-existing method of encoding the UCI for a single carrier cannot be directly used in CA since the eNB

needs to learn the total number of bits of the original information of UCI (Uplink Control Information) joint channel coding adopted by a UE, that is, to ensure that the eNB and UE have consistent understating on the total number of bits of the original information of UCI joint coding of multiple downlink carriers, so as to perform correct decoding. However, the existing method for transmitting UCI causes the eNB to decode the jointly encoded UCI incorrectly.

‘192 Patent Application at ¶ [0004].

The ‘192 Patent Application discloses an invention that provides a method, a UE and an eNB for transmitting joint UCI in CA so as to avoid the problem that the eNB decodes the jointly coded UCI incorrectly.

21. The invention requires that the eNB transmitting, and the UE receiving, a carrier activation command or a carrier deactivation command in a downlink subframe  $n$ . From this command, the UE shall update its downlink activated carrier set according to the received carrier activation/deactivation command into a second downlink activated carrier set. The second downlink activated carrier set is taken by the UE as a current downlink activated carrier set

corresponding to a first uplink subframe which must belong to a subframe set consisting of uplink subframe  $n+k$  and subframes thereafter.

22. It is required by the method disclosed in the application that the affected uplink subframe must be such that the positive integer  $k$  is greater than or equal to 5. In other words, the first possible effective uplink subframe after CA update may be subframe  $n+5$ .

23. To form the jointly coded UCI in CA, the UE shall sort  $X$  piece(s) of UCI corresponding to  $X$  downlink carrier(s) that belong to the current activated carrier set according to a sorting rule, wherein  $X$  is a positive integer. The UE shall then transmit the sorted  $X$  pieces of UCI to an eNB in the first uplink subframe which must be after subframe  $n+5$ .

24. With respect to the sorting and the innovation aspect of the '192 Patent Application, '192 proposes a sorting rule that is shared by both the UE and the eNB. The sorting rule allows the UE to organize the UCI from multiple CCs to be encoded in such a way that the eNB receiver can determine which piece of information corresponds to each carrier based on the pre-set rule. '192 Patent Application at ¶¶ [0032]-[0035].

25. More specifically, the '192 Patent Application discloses an inventive method for UCI transmission involving CA in 4G-LTE network, as is reflected in Claim 1:

*1. A method for transmitting uplink control information, comprising:*  
*receiving, by a user equipment (UE), a carrier activation command or a carrier deactivation command in a downlink subframe  $n$ ;*  
*updating, by the UE, a first downlink activated carrier set according to the received carrier activation command or the carrier deactivation command into a second downlink activated carrier set;*

*taking, by the UE, the second downlink activated carrier set as a current downlink activated carrier set corresponding to a first uplink subframe; wherein the first uplink subframe belongs to a subframe set of an uplink subframe  $n+k$  and uplink subframe(s) after the uplink subframe  $n+k$ ; and wherein  $n$  or  $k$  is a positive integer, and  $k$  is greater than or equal to 5:*

*sorting, by the UE,  $X$  piece(s) of Uplink Control Information (UCI) corresponding to  $X$  downlink carrier(s) according to a sorting rule, wherein  $X$  is a positive integer, and the  $X$  downlink carrier(s) belong to the current downlink activated carrier set; and*

*transmitting, by the UE, the sorted  $X$  pieces of UCI to a base station in the first uplink subframe.*

## **2. KEY ELEMENTS OF THE ‘192 PATENT APPLICATION’S INVENTION**

26. Mr. Davies’ reports that, according to the ‘192 Patent Application, before the invention,

base stations incorrectly decoded the jointly coded UCI they received from the user equipment, because the base station and user equipment lacked a common understanding of the number of bits of the original UCI after coding. The ‘192 Patent Application proposes an alternative method by:

*Establishing a common understanding of the length of the message between the user equipment and the base station.*

The ‘192 Patent Application asserts that prior to the invention it put forth, base stations lacked a way of identifying which piece of UCI corresponded to a particular downlink carrier. The ‘192 Patent Application proposes to solve this problem by:

*Organizing the information to be transmitted in such a way that the receiver can determine which piece of information corresponds to each carrier.*

Davies Rep. at ¶¶ 42-43.

27. Mr. Davies' summary does not fully capture the inventive aspect of the '192 Patent Application. As can be seen from the representative claim (Claim 1) above, the invention includes the steps of (a) the UE receiving the carrier activation/deactivation command in a downlink subframe  $n$  from the eNB; (b) the UE updating the current activated downlink carrier set based on the received command in downlink subframe  $n$ ; (c) the UE taking the current activated downlink carrier set to correspond to a first uplink subframe with subframe index  $n+k$ , wherein  $k$  is a positive integer greater than or equal to 5; (d) the UE sorting  $X$  pieces of UCI corresponding to  $X$  activated downlink carriers that belong to the current activated downlink carrier set according to a sorting rule; and (e) the UE transmitting the sorted UCI.

28. Mr. Davies' report only focused on steps (d) and (e) in the disclosed invention, and thereby neglected the importance of receiving and updating the current activated downlink carrier set in steps (a) and (b), without which steps (d) and (e) would not be possible. Furthermore, Davies' report failed to recognize the significance of sending the UCI on uplink subframes with indices of  $n+k$  in which  $k$  is a positive integer greater than or equal to 5 (step (c)). Requiring the transmission of UCI on uplink subframes with indices of  $n+k$  to correspond to the updated downlink carrier set based on command sent in downlink subframe  $n$  provides the necessary time that the UE requires to perform the necessary computation. In addition, the '192 Patent Application discloses such a delay allows both the eNB and the UE to synchronize the effective time of the carrier activation/deactivation command:

The first effective uplink subframe  $n+k$  refers to a first uplink subframe which needs to report UCI and which the UE encounters after  $k$  subframes since the

subframe  $n$  on which the UE receives the carrier activation command/deactivation command. A specific value of  $k$  may be selected according to an actual situation, for example,  $k$  is greater than or equal to 5.

Specifically, when UCI is ACK/NACK, the  $X$  downlink carrier(s) are all downlink carriers in the downlink carrier set of the UE: when UCI is CSI, the  $X$  downlink carrier(s) may be determined according to the downlink activated carrier set of the UE, CSI configuration configured by higher layers and whether aperiodic CSI is to be reported.

'192 Patent Application at ¶ [0161]-[0162]

It should be noted that, in this step, starting from the first effective uplink subframe  $n+k$ , the UE uses the updated downlink activated carrier set (that is, the downlink activated carrier set updated after the UE receives the carrier activation/deactivation command in the downlink subframe  $n$ ) as the current downlink activated carrier set, until the update needs to be performed again according to new carrier activation command/deactivation command.

*Id.* at ¶ [0164]

When the UE reports UCI, by delaying effective time of the carrier activation command/deactivation command, the problem that the base station decodes the jointly coded UCI incorrectly due to inconsistent understanding of the UE and eNB on the total number of original information bits of UCI joint coding of multiple downlink carriers may be solved.

*Id.* at ¶ [0010]

### 3. ESSENTIALITY OF THE ‘192 PATENT APPLICATION’S INVENTION

29. Exploiting the novelties and the advantages of the invention in the ‘192 Patent Application, 3GPP has adopted the invention in its 4G-LTE standard. Specifically, utilizing the invention, Sections 5.2.2.6 and 5.2.4.1 of 3GPP TS 36.212 V14.4.0 describe the channel coding of uplink control information (UCI) when carrier aggregation is involved. The activation of deactivation of additional secondary cells (component carriers) is disclosed in Section 5.13 of 3GPP TS 36.321 V14.4.0.

### 4. PERSON OF ORDINARY SKILL IN THE ART (POSITA) ALTERNATIVES

30. Mr. Davies’ report suggests that, many alternatives existed to the element of the ‘192 Patent Application that holds that a common understanding of the length of the UCI after channel coding must be established between the user equipment and the base station, to ensure the base station correctly decodes the jointly coded UCI in an LTE-A system with carrier aggregation. Additionally, many alternatives existed to establish the correspondence between a piece of UCI and a downlink carrier beyond the sorting of the UCI pieces according to a preset sorting rule.

Davies Rep. at ¶ 44.

31. Mr. Davies’ suggestions regarding the identity of these “many alternatives” include “Labeling”, “Preamble”, “Look-Up Table”, “Stop Message”, and “Patent Alternatives”. I disagree that these would have been considered alternatives by a POSITA, as I explain further below.<sup>2</sup> *Id.* at ¶¶ 44-56.

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<sup>2</sup> I adopt, for purposes of this report, Mr. Davies’ definitions of a POSITA for each of the patents and patent applications at issue. Davies Rep. at ¶¶ 28-31.



**a) HINDSIGHT**

32. Mr. Davies applied hindsight unavailable to a POSITA in proposing his so-called “(POSITA) Alternatives.” Mr. Davies does not identify or rely upon any prior art references, or cite any evidence at all, to support his opinion that a POSITA would have known about these alleged alternatives. Mr. Davies appears to have made up these “(POSITA) Alternatives” based on hindsight.

**b) “LABELING” IS NOT AN ALTERNATIVE**

33. Davies suggests that instead of reaching a common understanding regarding the encoding and decoding of joint UCI from multiple CCs *a priori* between the UE and the eNB when transmitting UCI, the UE may “label each of the pieces of UCI with a number, as well as an indication of how many total pieces of UCI are contained in the activated downlink carrier set.” *Id.* at ¶ 45. Mr. Davies claims that this “labeling” alternative would “obviate the need of the base station and the user equipment to calculate the number of bits of UCI after channel coding.” *Id.*

34. Mr. Davies fails to point out that this “labeling” approach would require additional label information be transmitted in addition to the jointly coded UCI. The additional labeling information would consume further uplink bandwidth. Instead of letting the eNB compute the total number of UCI bits and identifying the UCI for the activated carrier set transmitted by the UE, “labeling” would trade the more precious and limited bandwidth resources for small amount of computation saving by the basestation (eNB). A person of ordinary skill in the art would recognize such trade to be ill-conceived, particularly as the computation capability of the eNB is particularly strong. Instead of robbing the uplink bandwidth which could otherwise be used for faster data transmission, a POSITA would have certainly recognized this alternative to be undesirable.

35. Furthermore, a person of ordinary skill in the art would recognize that the suggested labeling would be totally incompatible with the previously existing UCI transmission for single carrier connections before the introduction of CA. A POSITA would have recognized that this lack of compatibility would increase the complexity of UE encoder and eNB receiver.

36. Mr. Davies fails to recognize that the inventive aspect of the ‘192 Patent Application allows the UE to sort the joint UCI information to be coded such that the eNB can uniquely separate the UCI for each activated downlink carrier without any additional bandwidth consumption. This is similar to pre-sorting X customer orders to a merchant based on a sorting rule such that the merchant knows which customer each order is from without having to write down on each order the name or other identification of the customer. Mr. Davies argues that his proffered labeling methodology would “ensure that the base station understood how many UCI pieces it should receive. If the base station did not receive the expected number of UCI pieces, it could identify the missing piece and request that it be retransmitted.” *Id.* However, Mr. Davies fails to point out that a person of ordinary skill in the art would recognize this approach to be undesirable to wireless operators as it would require even more bandwidth resources, and therefore would not be an acceptable alternative to the ‘192 Patent Application for a POSITA.

**c) “PREAMBLE” IS NOT AN ALTERNATIVE**

37. Mr. Davies suggests that instead of reaching a common understanding regarding the encoding and decoding of joint UCI from multiple CCs *a priori* between the UE and the eNB when transmitting UCI, an alternative “would have been to affix a preamble to the jointly channel coded UCI describing how many total pieces of UCI are contained in the activated downlink carrier set.” *Id.* at ¶ 47.

Additionally, a POSITA would have known that a plausible alternative to sorting each piece of UCI according to a preset sorting rule to decipher which piece of UCI was associated with which downlink carrier, would be affixing a preamble to the jointly channel coded UCI describing the relationship of each piece of UCI to each downlink carrier.

*Id.* at ¶ 48.

38. Mr. Davies recognizes that this alternative of “preamble” is equivalent to the alternative of labeling.

The preamble methodology is more explicit than sorting according to a preset sorting rule laid out by the ‘192 Patent Application, but less explicit than the labeling, as it only establishes the correspondence between the pieces of UCI and downlink carriers at the beginning of the jointly channel coded UCI message.

*Id.*

Therefore, given that the only difference between preamble and labeling is the position of the jointly channel coded UCI message, a person of ordinary skill in the art would recognize that the suggested preamble alternative suffers from the same shortcomings as the suggested preamble alternative.

39. Mr. Davies’ suggested use of preamble would require additional preamble bits be transmitted in addition to the jointly coded UCI. The additional preamble information would consume further uplink bandwidth. Instead of letting the eNB compute the total number of UCI bits and identifying the UCI for the activated carrier set transmitted by the UE, “labeling” would trade the more precious and limited bandwidth resources for small amount of computation saving by the basestation (eNB). A person of ordinary skill in the art would recognize such trade to be

ill-advised, particularly as the computation capability of the eNB is particularly strong. Because a preamble methodology would rob the uplink bandwidth, which could otherwise be used for faster data transmission, a POSITA would have recognized this alternative to be undesirable. Furthermore, a POSITA would recognize that sending a preamble to UCI would be totally incompatible with the previously existing UCI transmission for single carrier connections before the introduction of CA. A POSITA would have recognized that this lack of compatibility would increase the complexity of UE encoder and eNB receiver.

40. Mr. Davies fails to recognize that the inventive aspect of the ‘192 Patent Application allows the UE to sort the joint UCI information to be coded such that the eNB can uniquely separate the UCI for each activated downlink carrier without any additional bandwidth consumption. This is similar to pre-sorting X customer orders to a merchant based on a sorting rule such that the merchant knows which customer each order is from without having to write down on each order the name or other identification of the customer. Mr. Davies suggest that an alternative “would be affixing a preamble to the jointly channel coded UCI describing the relationship of each piece of UCI to each downlink carrier.” *Id.* However, Mr. Davies fails to point out that this approach would require a sufficiently long preamble to be reserved to account for different CA scenarios. A POSITA would recognize that the transmission of such preamble would be undesirable to wireless operators, as it would require even more bandwidth resources. Therefore, a “preamble” scheme would not have been considered as an alternative to the ‘192 patent application by a POSITA.

**d) “LOOK-UP TABLE” IS NOT AN ALTERNATIVE**

41. Without providing specifics, Mr. Davies suggested a look-up table as an alternative to the claimed sorting step.

A person of ordinary skill in the art would have known that a plausible alternative to sorting each piece of UCI according to a preset sorting rule to decipher which piece of UCI was associated with which downlink carrier, would be to have a base station reference a look-up table to decipher the relationship of each piece of UCI to each downlink carrier.

*Id.* at ¶ 49.

42. Mr. Davies fails to explain how such a look-up table is not a sorting rule. In fact, to a person of ordinary skill in the art, a look-up table must be shared and pre-determined between the UE and the eNB. Such agreement is, in fact, a sorting rule as disclosed by the ‘192 Patent Application. To the extent that Mr. Davies argues that such look-up table may be transmitted by the eNB to the UE, a person of ordinary skill in the art would recognize that a look-up table must be sufficiently large to accommodate various cases of carrier aggregation and different types of UCI joint code, and that transmitting such a look-up table requires additional encoding, modulation, and bandwidth resources, without providing any actual benefit. Therefore, a “look-up table” would not have been considered an alternative to the ‘192 Patent Application by a POSITA.

**e) “STOP MESSAGE” IS NOT AN ALTERNATIVE**

43. Mr. Davies suggests that instead of letting the eNB calculate the total length of UCI in terms of coded bits, an alternative to,

establishing a common understanding of the length of UCI after channel coding between the user equipment and the base station would have been to affix a stop message at the end of the jointly channel coded UCI. The stop message methodology has many benefits. For one, it would obviate the need of the base

station and the user equipment to calculate the number of bits of UCI after channel coding.

*Id.* at ¶ 50.

44. A POSITA would have recognized that a “stop message” must be unique and must be encoded to be identifiable to the receiving eNB. A POSITA would have recognized that encoding an additional stop message would increase the length of the jointly coded UCI, thereby consuming additional bandwidth resources in the uplink. Furthermore, a POSITA would have recognized that adding a stop message to the end of jointly coded UCI is not compatible with the pre-existing UCI channel code for single carrier downlink. A POSITA would have recognized that this lack of compatibility would increase the complexity of UE encoder and eNB receiver. Therefore, a “stop message” would not have been considered an alternative to the ‘192 Patent Application by a POSITA.

**f) THE PATENTS MR. DAVIES IDENTIFIED ARE NOT ALTERNATIVES**

**1) US20110242997A1 APPLICATION (‘997) IS NOT AN ALTERNATIVE**

45. Mr. Davies recites the US20110242997A1 Patent Application Publication (“the ‘997 Patent Application”), *Extended uplink control information (UCI) reporting via the physical uplink control channel (PUCCH)*, with a priority date of April 2, 2010 as an alternative to the ‘192 Patent Application. The ‘997 Patent Application relates to the encoding and transmission of the extended UCI. According to Mr. Davies, the ‘997 Patent Application “discloses the use of bits at the beginning of the UCI message, these bits correspond to a symbol. The symbol is then used [to] encode the UCI, which can then be sent to the base station, and the base station could use the symbol to decode the UCI message.” *Id.* at ¶ 51.

46. A POSITA would have recognized that the ‘997 Patent Application does not disclose an alternative to the ‘192 invention. In fact, the ‘997 Patent Application would still require the steps of the invention as shown in the representative Claim 1 of the ‘192 Patent Application. Specifically, claim 1 of the ‘997 Patent Application discloses

Claim 1: A method for reporting uplink control information (UCI), comprising:  
encoding a first part of the UCI in a single physical uplink control channel (PUCCH) symbol;  
selecting a channel of the PUCCH symbol to implicitly encode a second part of the UCI in the PUCCH symbol; and  
transmitting the PUCCH symbol via a single PUCCH signal.

‘997 Patent Application at 8.

47. A POSITA would recognize that this claim of the ‘997 Patent Application relates only to one element of the claims of the ‘192 Patent Application. Claim 1 of the ‘997 Patent Application requires encoding a first part and a second part (i.e. extended UCI) in the PUCCH symbol and transmitting the PUCCH symbol via a single PUCCH signal. A POSITA would recognize that Claim 1 of the ‘997 Patent Application relates only to claimed element (e) of the ‘192 Patent Application for “transmitting, by the UE, the sorted X pieces of UCI to a base station in the first uplink subframe.”

48. A POSITA would have recognized that the invention of the ‘997 Patent Application does not address the encoding and decoding of multiple UCI pieces corresponding to the multiple activate downlink carrier in CA scenario. As recognized in Mr. Davies’ report, a number of coded UCI bits for implicit transmission may be determined using channel selection.

“Paragraph [0015]: The PUCCH symbol may be configured for uplink signaling. A number of coded UCI bits for *implicit transmission* may be determined using channel selection. Selecting a channel of the PUCCH symbol may include generating a first bit or the first bit and a second bit of the coded UCI bits using a table. The first bit or the first bit and the second bit may be transmitted in the PUCCH symbol.

Davies Rep. at ¶ 53 (citing ‘997 Patent Application at ¶ 15) (emphasis added).

49. A POSITA would have understood that the eNB may use the channel selection bits encoded in the first PUCCH symbol to indicate the number of extended UCI symbols (2<sup>nd</sup> part) that may follow. However, the number of extended UCI symbols does not describe how individual UCI for each of the activated downlink carriers are encoded.

50. Based on at least the reasons stated above, a POSITA would also have recognized that the ‘997 Patent Application does not address the steps a)-d) of the representative Claim 1 in the ‘192 Patent Application. Therefore, a POSITA would not have considered the ‘997 Patent Application as an alternative to the ‘192 Patent Application.

## 5. CN102282819A PATENT APPLICATION (‘819) IS NOT AN ALTERNATIVE

51. Mr. Davies’ points to the CN102282819A Patent Application (“the ‘819 Patent Application”), *Multi-carrier wireless communication system and a transmission method of an uplink control information link means*, with a priority date of January 13, 2009, as providing an alternative.

52. However, as Mr. Davies admits, Claim 6 puts forth an approach of delivering UCI messages which allows for the messages to be segmented and delivered over a plurality of channels, rather than on



a single channel. This differs from the ‘192 Patent Application in that rather than delivering the UCI in a single channel and associating the UCI for each carrier by ordering, the UCI corresponding to each carrier is based on the channel used to deliver the UCI for each carrier.

Davies Rep. at ¶55.

53. A POSITA would have understood that transmitting UCI “over a plurality of channels” would not only be wasteful because of the inefficient use of more channel bandwidth from multiple component carriers, but often infeasible.

In LTE-A, the number of downlink 108 carriers may be asymmetric from the number of uplink 106 carriers. Thus, the number of uplink 106 component carriers (CC) may not be the same as the number of downlink 108 component carriers (CC). Directly mapping of an uplink 106 component carrier (CC) and downlink 108 component carrier (CC) is not possible.

‘997 Patent Application at [0033].

54. Based on at least the reasons stated above, a POSITA would have recognized that the ‘819 Patent Application cannot be a viable alternative to the ‘192 Patent Application.

## **B. U.S. PATENT APPLICATION PUBLICATION NO. 2009/0303956 A1**

### **1. SUMMARY OF THE ‘956 PATENT APPLICATION**

55. U.S. Patent Application Publication No. 2009/0303956 A1 (the ‘956 Patent Application), *Method, device and system for assigning ACK channels to users*, with a priority date of April 29, 2008, granted as US Patent No. 8,243,669, was the U.S. counterpart to CN201110264130. The ‘956 Patent Application provides a method and a system, in TDD LTE mode, for establishing multiple acknowledge (ACK) channels corresponding with a plurality of

downlink subframes on one uplink subframe to be used by a UE to transmit its feedback signal. This is a unique condition for multiple configurations in TDD mode. Furthermore, setting up multiple ACK feedback channels on a single uplink subframe can also free up resources and improve spectral efficiency of wireless networks in general.

56. More specifically, in the TDD mode of LTE that is configured with 5ms switch point periodicity, each radio frame of 10ms is divided into two half-frames that are 5 ms each. Each half-frame consists of eight slots that are respectively 0.5 ms long and contain three special fields, DwPTS, GP, and UpPTS. Every two slots form one subframe, and the three special fields, DwPTS, GP, and UpPTS form a special subframe. Among the subframes, subframes 0 and 5 are for downlink, subframe 2 is an uplink subframe, subframe 1 is a special subframe, subframe 6 may be configured as either downlink or special subframe, and the remaining 5 subframes may be configured as either uplink or downlink, as shown in Table 4.2-2 in section 4.2 of 3GPP TS 36.211 v14.2.0. The ratio of downlink to uplink subframes can flexibly be configured to meet data service needs. There are 7 configurations of different downlink to uplink subframe ration, among which, except the two ratios of 1-to-3 in 5 ms switch periodicity (i.e. uplink-downlink configuration 0) and 3-to-5 in 10 ms switch periodicity (i.e. uplink-downlink configuration 0), all other ratios are required to provide feedback ACK channels for multiple downlink subframes in one uplink subframe. For example, according to Table 10.1.3.1-1 of 3GPP TS 36.213 V14.2.0, in configuration 2, each uplink subframe is responsible for feeding back ACK/NACK information for up to 3 downlink subframes involving multiple scheduled UEs. .

57. The '956 Patent Application inventors provided a new method for supporting ACK/NACK feedback on physical uplink control channel (PUCCH) corresponding to more than one downlink subframe on a single uplink subframe for TDD-mode LTE networks. The invention

consists of a method or a system for assigning ACK channels to a UE to feed back ACKs of N downlink subframes in one uplink subframe. The method establishes a linkage relationship between uplink ACK channel index in one uplink subframe and index of control channel elements in multiple downlink subframes. The method includes the following steps.

Firstly, reserved ACK channels are divided into N blocks; each downlink sub-frame is assigned with a mapping label d, in which each mapping label corresponds to one block; and each block is divided into a plurality of sub-blocks, and each sub-block is assigned with a sub-block label m. Then, the ACK channels are assigned to the downlink sub-frames according to a sequence of increasing the mapping label d first and then increasing the sub-block label m.

‘956 Patent Application at ¶¶ [0015]-[0016]. A representative claim (Claim 1) of ‘956 is reproduced here:

*1. A method for assigning ACK channels to a user, which is used to feed back ACKs of N downlink sub-frames in one uplink sub-frame, the method comprising:*

*dividing reserved ACK channels into N blocks:*

*assigning each downlink sub-frame with a mapping label*

*d, each mapping label corresponding to one block;*

*dividing each block into a plurality of sub-blocks, each*

*sub-block being assigned with a sub-block label m; and*

*assigning the ACK channels to the downlink sub-frames*

*according to a sequence of increasing the mapping label*

*d first and then increasing the sub-block label m;*

*the  $N$  being a positive integer.*

## 2. KEY ELEMENTS OF THE ‘956 INVENTION

58. The ‘956 Patent Application explains the practical contribution of the invention to wireless bandwidth savings:

According to the embodiments of the present invention, the reserved ACK channels are divided into blocks according to the downlink sub-frames, each block is divided into a plurality of sub-blocks, and the CCE sets within the same sub-frame are respectively mapped to different sub-blocks, so as to release unused ACK channel resources as whole blocks to form more RBs for the transmission on other channels, for example, PUSCH transmission. Alternatively, ACK channels are consecutively mapped to each sub-frame among the reserved ACK channels, so as to release unused ACK channel resources as whole blocks, thereby saving the ACK channel resources. Alternatively, a plurality of consecutive CCEs is mapped to one ACK channel, or a plurality of downlink sub-frames is assigned with the same mapping label, so as to reduce the overhead of resource reservation, thereby saving the ACK channel resources.

‘956 Patent Application at ¶ [0028].

59. The key aspects of the invention of the ‘956 Patent Application consist of 4 major elements: (a) a reservation unit for reserving the ACK channels; and an assignment unit for (b) dividing ACK channels into  $N$  blocks and assigning each downlink sub-frame with a mapping label  $d$  corresponding to one block; (c) further dividing each block into a plurality of sub-blocks, each sub-block being assigned with a sub-block label  $m$ ; and (d) assigning the ACK channels to

the downlink sub-frames in the order of increasing the mapping label  $d$  first and then increasing the sub-block label  $m$ .

60. The ‘956 Patent Application discloses a device for implementing the invention.

A device for assigning ACK channels to a user provided in one embodiment of the present invention includes a reservation unit and an assignment unit. The reservation unit is configured to reserve ACK channels for  $N$  downlink sub-frames. The assignment unit is configured to divide the reserved ACK channels into  $N$  blocks; assign each downlink sub-frame with a mapping label  $d$  according to a preset rule, in which each mapping label corresponds to one block; divide each block into a plurality of sub-blocks; and assign the ACK channels to the downlink sub-frames according to a sequence of increasing the mapping label  $d$  first and then increasing a sub-block label  $m$ .

‘956 Patent Application at ¶ [0024].

### **3. ESSENTIALITY OF THE ‘956 INVENTION**

61. Taking advantage of the novelties and the benefits of the invention in the ‘956 Patent Application, 3GPP has adopted the invention in its 4G-LTE standard. Specifically, Section 10.1.3 of 3GPP TS 36.213 V14.2.0 utilizes the inventions of the ‘956 Patent Application to specify the TDD HARQ-ACK feedback procedures for UEs in EUTRAN systems. Section 5.4 of 3GPP TS 36.211 v14.2.0 utilizes the invention of the ‘956 Patent Application to specify the relevant PUCCH formats.

### **4. PERSON OF ORDINARY SKILL IN THE ART (POSITA) ALTERNATIVES**

62. Mr. Davies’ report suggests that “[t]here exist many alternatives to the ACK channel allocation scheme presented in the ‘956 Patent Application, all of which would have been

well understood and deemed plausible by a POSITA at the time of the filing date.” Davies Rep. at ¶ 66.

63. Mr. Davies’ suggested alternatives include “Extremes”, “Symbols”, and “Patent Alternatives”. *Id.* at ¶¶ 66-76.

**a) HINDSIGHT**

64. Mr. Davies applied hindsight unavailable to a person of ordinary skill in the art (POSITA) in proposing his so-called “(POSITA) alternatives.” Mr. Davies does not identify or rely upon any prior art references, or cite any evidence at all, to support his opinion that a POSITA would have known about these alleged alternatives. Mr. Davies appears to have made up these “(POSITA) alternatives” based on hindsight.

**b) “EXTREMES” IS NOT AN ALTERNATIVE**

65. Mr. Davies suggests that, a plausible alternative channel allocation method would have been to map channels to available sub-frames by alternating between extremes in the time domain. That is, channels would be positioned in time in an alternating fashion between the earliest available position and the latest available position. In this scheme, any channels allocated to a group of frames would exist at the temporal boundaries, leaving all additional free blocks in the temporal center of the group.

*Id.* at ¶ 67.

A POSITA would not have viewed such a proposal to be an alternative to the invention in ‘956 Patent Application.

66. A POSITA would have recognized that Mr. Davies’ suggested “Extremes” alternative, based on hindsight, only addresses the reservation of ACK channels in the uplink

subframe, i.e., it only addresses element (a) of the representative claim. The suggested “Extreme” channel assignment does not address elements (b)-(d) of the representative claims. A POSITA would have understood that, without dividing the downlink ACK channels into N blocks with block labels, and further dividing each block into a plurality of sub-blocks with sub-block labels, the suggested alternative does not address the key objective of using one uplink subframe to carry multiple ACK channels for the downlink frames.

67. Mr. Davies further suggests that the “extremes” alternative could be used for, allocating the necessary channels in a particular order. For example, the channels to be mapped to the available network resources could first be ranked according to their CCE length. The channel demanding the most network resources would be allocated first, at the earliest position. Next, the shortest channel would be allocated at the last possible position. The second-most resource-intensive channel would be allocated next and be placed directly after the first channel, at the earliest position available. The second-shortest channel would be allocated next in the latest available position, and so on. Once again, any free resources will be pooled between the earliest and latest blocks of channels. Additionally, this temporal distribution of channels according to size will increase the probability that any given channel release will result in the clearing of usable blocks. The free resource pool initially restricted to the temporal center will be adjacent to the two channels closest to the median channel CCE length. Assuming for example the probability of any given channel release being equal, this configuration increases the expected value of the number of frames, and therefore resource blocks, that will be formed in contiguity to the central pool of free network resources upon any given release. This allocation

scheme essentially tries to pool as many free resources as possible up-front and hedges against fragmentation risk by separating the most resource-intensive channels from the least resource-intensive channels in the time domain.

*Id.*

68. A POSITA would have recognized that Mr. Davies' suggested "extremes" method is not an alternative since it fails to consider the practical constraints imposed by real-world wireless communication networks like LTE TDD, and is meaningless at least for the following reasons.

69. For example, in LTE TDD, the number of downlink subframes that are required to feedback ACK/NACK information on a same uplink subframe, is determined by the uplink-downlink configuration, as specified in Table 10.1.3.1-1 of 3GPP TS 36.213 v14.2.0. For this reason, Mr. Davies' assertion that "[a]ssuming for example the probability of any given channel release being equal, this configuration increases the expected value of the number of frames" (*Id.*) is a meaningless hypothetical that is far from reality.

70. Similarly, Mr. Davies ignored practical LTE system constraints by suggesting to rank ACK channels according to their CCE length. "For example, the channels to be mapped to the available network resources could first be ranked according to their CCE length. The channel demanding the most network resources would be allocated first, at the earliest position. Next, the shortest channel would be allocated at the last position." *Id.* However, the uplink ACK channels of PUCCH format 1a/1b are of equal size in LTE, corresponding to 1/18 of a RB. Hence, it does not make sense to rank ACK channels according to their length. Furthermore, CCE is used to construct physical downlink control channel (PDCCH) and has fixed size. It would have been well



known to a POSITA that CCE is not used to construct uplink ACK channel. Mr. Davies' suggestion confuses the CCE in PDCCH with the RB of the PUCCH and is practically meaningless.

71. A POSITA would have understood that the claim element (d) of the '956 Patent Application for assigning the ACK channels to the downlink sub-frames in the order of increasing the mapping label *d* first and then increasing the sub-block label *m* would offer substantial signaling simplicity and bandwidth savings when the network side device consisting of a reservation unit and an assignment unit assigns ACK channels to a UE in connected state. To the extent that Mr. Davies' argues his suggestion of channel ranking according to their CCE length was meant to suggest channel ranking according to their resource lengths, a POSITA would have recognized that the suggested allocation to the extremes based on the required resource lengths would require more complex assignment signaling and consume more control channel bandwidth, particularly when a large number of UEs are being served by the network. For at least these reasons, Mr. Davies' "extremes" method would not have been considered an acceptable alternative by a POSITA.

**c) "SYMBOLS" IS NOT AN ALTERNATIVE**

72. Mr. Davies suggested that "multiple ACK/NACK messages related to downlink sub-frames could be combined and sent on a single uplink channel if the control information is placed in a single data stream and then multiplexed with a user data stream using a modulation scheme such as phase-shift keying." *Id.* at ¶ 69.

73. The '956 Patent Application focuses on allocating uplink ACK channels corresponding to multiple downlink sub-frames on a single uplink sub-frame. What modulation scheme to use for transmitting ACK/NACK information on the allocated uplink ACK channels is another issue. A POSITA would have recognized that modulating and encoding ACK/NACK

information can directly be applied when transmitting ACK/NACK information on the uplink ACK channels based on the invention of the '956 Patent Application. Section 5.2.3 of 3GPP standard TS 36.212 clearly discloses such encoding ("Each positive acknowledgement (ACK) is encoded as a binary '1' and each negative acknowledgement (NACK) is encoded as a binary '0'."). Specifically, Table 5.4-1 of 3GPP standard TS 36.211 v14.2.0 illustrates a plurality of supported PUCCH formats, in which every format supports a phase-shift keying. In particular, format 1a applies binary phase-shift keying (BPSK) modulation whereas format 1b, format 2, format 3 all apply quadrature phase-shift keying (QPSK) modulation. Section 7.1.1 and Section 7.1.2 of 3GPP standard TS 36.211 v14.2.0 discloses modulation for BPSK and QPSK respectively. A POSITA would have understood that since the '956 Patent Application relates to the transmission of PUCCH, the ACK channels must be transmitted by using phase-shift keying modulation even though the '956 does not explicitly explain modulation to be phase-shift-keying. For this reason, use of "symbols" as described by Mr. Davies does not represent an alternative solution of the invention of the '956 Patent Application.

74. Mr. Davies appears to suggest that multiple ACK channels corresponding to the multiple downlink subframes be combined into a single message stream and jointly transmitted with a user payload stream.

[T]he control information is placed in a single data stream and then multiplexed with a user data stream using a modulation scheme such as phase-shift keying. In such a system, individual bits of control information and user data can be combined and simplified into symbols, also sometimes called constellations, that encode information from two separate data streams.

Davies Rep. at ¶ 69.

Uplink transmission of multiplexed ACK channels with UE payload would require scheduled PUSCH for payload uplink. Particularly, in the cases when the UE has no payload to transmit or has not received PUSCH scheduling, then the UE ACK feedback would have to rely on PUCCH. The '956 Patent Application specifically addresses the problem of ACK channel transmission on PUCCH. Thus, a POSITA would have recognized that this "symbols" method is not an alternative.

75. Furthermore, to the extent that Mr. Davies suggests that multiple ACK/NACK messages should be combined and jointly modulated into symbols using a large constellation which has to be jointly received and decoded, a POSITA would have recognized that with as many as 8 downlink subframes, the erroneous reception by the eNB of the jointly encoded ACK/NACK messages would lead to the ACK/NACK errors of all the downlink subframes. Such a PUCCH transmission error would require the retransmission of all the data blocks in the downlink subframes whose ACK channels are multiplexed. A POSITA would have recognized that such ACK encoding would lead to substantial increase of spectral resources for downlink data block retransmission.

76. Mr. Davies further asserts that  
 binary phase-shift keying (BPSK) allows twice as much data to be transmitted per symbol as [sic] would be transmitted on a normal, unmodulated channel . . .  
 Combining ACK/NACK transmissions with user data and phase-shift key modulating the allocated resulting channel succeeds in improving network resource utilization and efficiency, albeit in a very different way than the method of the '956 Patent Application.

*Id.* at ¶ 69.

First, this statement discusses different ways to modulate data signals for transmission but does not address the invention of the ‘956 Patent Application which focuses on supporting ACK/NACK feedback corresponding to more than one downlink subframe on a single uplink subframe for TDD-mode LTE networks. First, a “normal, unmodulated channel” cannot carry payload data. It is therefore meaningless to compare BPSK modulation with an unmodulated channel. Second, as explained earlier, Table 5.4-1 of 3GPP standard TS 36.211 v14.2.0 illustrates a plurality of supported PUCCH formats, each supporting a phase-shift keying. In particular, format 1a applies binary phase-shift keying (BPSK) modulation whereas format 1b, format 2, format 3 all apply quadrature phase-shift keying (QPSK) modulation. A POSITA would have understood that since the ‘956 Patent Application relates to the transmission of PUCCH, the ACK channels must be transmitted by using phase-shift keying modulation even though the ‘956 Patent Application does not explicitly explain modulation to be phase-shift-keying.

77. Based on at least the reasons stated above, a POSITA would not have considered “symbols” to be an alternative to the invention of the ‘956 Patent Application.

**d) THE PATENTS MR. DAVIES IDENTIFIED ARE NOT ALTERNATIVES**

**1) US 2010/0322114 A1 (‘114) IS NOT AN ALTERNATIVE**

78. The Davies report proposes as an alternative US 2010/0322114 A1 Patent Application Publication (“the ‘114 Patent Application”), *Method for allocating uplink ACK/NACK channels*, with priority date of Feb. 4, 2008. The ‘114 Patent Application provides a method for allocating uplink ACK/NACK channels for downlink data transmission in a wireless communication system.

79. According to one aspect of its invention, a method for binding CCE and ACK/NACK in a downlink sub-frame is provided. The specific steps of the '114 Patent Application involve multiple downlink subframes:

According to another aspect of present invention, a method for impliedly binding CCE and ACK/NACK in a plurality of downlink sub-frames comprising steps of:

a) a Node B transmitting downlink physical control channels and downlink data in the plurality of downlink sub-frames respectively;

b) a UE detecting THE downlink physical control channels in the plurality of sub-frames and receiving the downlink data transmitted from the node B accordingly;

c) UE obtaining indexes of ACK/NACK channel in an uplink sub-frame based on a minimum CCE index of the downlink physical control channels and the indexes of downlink sub-frames occupied for downlink data transmission, and transmitting ACK/NACK signals;

d) the Node B receiving ACK/NACK channels of uplink sub-frame and detecting ACK/NACK information of downlink data scheduled in each downlink sub-frame.

'114 Patent Application at ¶¶ [22]-[26].

80. A POSITA would have recognized that, unlike the invention of the '956 Patent Applications, the key steps of the '114 Patent Application are for the UE to detect the downlink physical control channels in the plurality of subframes and to obtain the indices of the ACK/NACK channel in an uplink subframe based on a minimum CCE index of the downlink physical control

channels and the indices of downlink subframes occupied for downlink data transmission, and transmitting ACK/NACK signals.

81. More specifically, the ‘114 Patent Application does not address any one of the elements (a)-(d) disclosed in the invention of the ‘956 Patent Applications. The ‘114 Patent Application discloses neither a reservation unit for reserving the ACK channels, nor an assignment unit for reserving the ACK channels dividing ACK channels into N blocks and assigning each downlink sub-frame with a mapping label d corresponding to one block; further dividing each block into a plurality of sub-blocks, each sub-block being assigned with a sub-block label m; and assigning the ACK channels to the downlink sub-frames in the order of increasing the mapping label d first and then increasing the sub-block label m.

82. Based on at least the reasons stated above, a POSITA would not have viewed the ‘114 Patent Application as an alternative method.

## **2) US 2009/0285122 A1 (‘122) IS NOT AN ALTERNATIVE**

83. The Davies report proposes as an alternative US 2009/0285122 A1 Patent Application Publication (“the ‘122 Patent Application”), *Uplink control for time-division duplex with asymmetric assignment*, with priority date of April 21, 2008. The ‘122 Patent Application proposes “a hybrid bundling module configured to provide a hybrid ACK/NAK bundling structure for an uplink ACK/NAK entity from user equipment, wherein the hybrid ACK/NAK bundling structure corresponds to an uplink-downlink configuration of subframe assignments.” ‘122 Patent Application at ¶ [0005].

84. The ‘956 Patent Application deals with the problem to allocate uplink ACK channels corresponding to multiple downlink sub-frames on a single uplink sub-frame over PUCCH. How to transmit the ACK/NACK information on the allocated uplink ACK channels is

another question. There existed at least two transmission schemes that are compatible with the '956 Patent Application for ACK/NACK transmission on the allocated uplink ACK channels: HARQ-ACK bundling and HARQ-ACK multiplexing. The '122 Patent Application discusses how to transmit ACK/NACK information on the allocated uplink ACK channels, by bundling multiple ACK/NACK bits into a bundled ACK/NACK bit through a logical AND operation. A POSITA would have recognized that this method of hybrid ACK/NACK bundling is a different design component for feeding back multiple ACK/NACK information in assigned uplink ACK channel and, therefore, is not an alternative to the '956 Patent Application.

85. A POSITA would also have recognized that hybrid ACK/NACK bundling disclosed in the '112 Patent Application is a well known practice in the prior art. In particular, documents R1-080870 and R1-081110 in 3GPP TSG RAN WG1 meeting #52 (Feb. 11-15, 2008) explicitly describe the process of ACK/NACK bundling which combines multiple ACK/NACK for transmission in a single ACK channel. A POSITA would have recognized that, unlike the process of ACK/NACK multiplexing in an uplink subframe, which contains multiple ACK/NACK feedback channels and is also disclosed in R1-081110, ACK/NACK bundling is not an alternative technology and is used when reporting ACK/NACK of multiple data blocks or subframes under limited PUCCH resources. A POSITA would have recognized that by bundling ACK/NACK messages of multiple downlink subframes, erroneous reception by the eNB of bundled ACK/NACK message would lead to the reception errors of ACK/NACK messages for all the downlink subframes. Such a PUCCH transmission error would compel the retransmission of all the data blocks in the downlink subframes involved in the bundling even if only one data block within the bundled downlink subframes is received erroneously. This is because the eNB would not have been able to distinguish which ones of the bundled data blocks are correctly received. As

explained in R1-080870, an ACK is generated only if all assigned DL subframes are received correctly, whereas a NACK is generated otherwise.

For simplicity, let us consider the single code block case in which a single ACK/NACK is generated for each DL subframe and that PUCCH formats carrying a single ACK/NACK bit are used. The idea with bundling is then to generate a single ACK/NACK report based on the ACK/NACKs of the assigned subframes. A simple rule is to generate an ACK only if all assigned DL subframes are received correctly, whereas a NACK is generated otherwise.

R1-080870 at 1.

86. A POSITA would have recognized that ACK encoding according to the ‘122 Patent Application would lead to a substantial increase of required spectral resources for downlink data block retransmission. The growth of required spectral resources used for downlink data block retransmission to remedy possible packet loss means the corresponding loss of spectral efficiency. Because a primary goal of wireless design is to make efficient use of spectral resources for data transmission, a POSITA would not have viewed ACK/NACK bundling as a viable alternative to the ‘956 Patent Application.

87. Based on at least the reasons stated above, a POSITA would have recognized that the ‘122 Patent Application does not provide an alternative to the invention of the ‘956 Patent Application.

### **3) KR20080096351A IS NOT AN ALTERNATIVE**

88. The Davies’ report proposes as an alternative KR20080096351A Patent Application Publication (“the ‘351 Patent Application”), *A method for transmitting control channel in a communication system*, with priority date of April 27, 2007. The ‘351 Patent



Application discloses a method for transmitting a control channel in a communication system by mapping a virtual resource to a physical resource and using a block interleaver. As Davis' report suggests, according to the '351 Patent Application, "individual control channel elements (CCEs) are grouped and then permuted within the group to conform to a predetermined pattern by an interleaver. The permuted CCEs are then mapped to the physical resource (or channel) and this mapped control channel is transmitted." Davies Rep. at ¶ 75.

89. The '351 Patent Application does not target the problem of transmitting multiple ACK channels corresponding to multiple downlink subframes in an uplink subframe of TDD mode. By its own terms, the '351 Patent Application addresses the transmission of a control channel for cellular communication in a multicell environment: "This document relates to a method of transmitting a control channel in a communication system in a communication system to more specifically relates to a communication system and a multiple-cell environment, by using the cell specific information." '351 Patent Application at Description.

90. A POSITA would have recognized that the '351 Patent Application considers a different problem from that of the '956 Patent Application. Specifically, the '351 Patent Application does not disclose the reservation unit for (a) reserving ACK channels, the assignment unit for (b) dividing ACK channels into N blocks and assigning each downlink sub-frame with a mapping label d corresponding to one block, (c) further dividing each block into a plurality of sub-blocks, each sub-block being assigned with a sub-block label m, and (d) assigning the ACK channels to the downlink sub-frames in the order of increasing the mapping label d first and then increasing the sub-block label m.

91. The cited portions by Mr. Davies from the '351 Patent Application are only related to the mapping of control channel elements (CCEs) to the physical resources in downlink, which

are not relevant to the problem of the ‘956 Patent Application which focuses on allocating ACK channels corresponding to multiple downlink subframes on a single uplink subframe. A POSITA would not have recognized any cited portions by Mr. Davies to be related to the ‘956 invention.

92. Based on at least the reasons stated above, a POSITA would have recognized that the ‘351 Patent Application does not provide an alternative to the invention of the ‘956 Patent Application.

### C. CHINESE PATENT NO. CN100571106C (‘106)

#### 1. SUMMARY OF THE ‘106 PATENT

93. Chinese Patent No. CN100571106C, *Wireless Network Communication Device*, (the ‘106 Patent) with priority date of March 22, 2006, was issued from CN200610058405. The ‘106 Patent provides “a new wireless network communication device in response to the newly proposed AM and UM entities of the EUTRAN system to support functions not supported in Release 6 protocol to improve system performance.” ‘106 Patent at 4.

94. In the EUTRAN architecture, the conventional radio interface protocol is shown in Figure 2 (reproduced below), wherein the radio interface protocol is divided into three layers: the physical layer (L1), a data link layer (L2), a network layer (L3). L2 comprises the following sublayers: media access control (MAC), Radio Link Control (RLC), Packet Data Convergence Protocol (PDCP), and broadcast / multicast control protocol (BMC). In general, RLC layer supports three types of operations, a transparent mode (TM) service, unacknowledged mode (UM) service, and an acknowledged mode (AM) service.

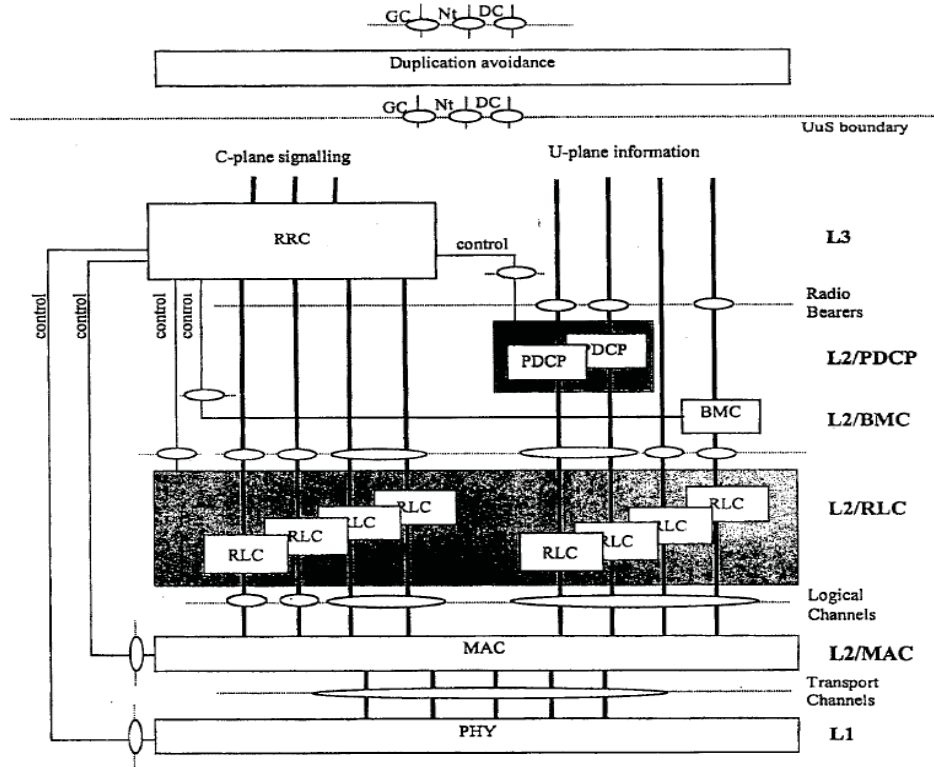


Figure 2 (the '106 Patent)

95. The '106 Patent invention discloses a wireless network communication device comprising at least one type of upper layer automatic retransmission request (ARQ) entity; said upper layer ARQ being an acknowledged mode ARQ entity; said ARQ entity further having a transmitting part and a receiving part; said transmitting part further comprising segmentation-concatenation element for data unit segmentation/concatenation, retransmission buffer element for buffering protocol data units after segmentation/concatenation and for processing the buffered protocol data units; said receiving part further comprising: a reordering element for sorting received protocol data units; reassembly element for reassembling sorted protocol data units (PDUs) into service data units (SDUs) for submitting to upper layers;

wherein said step of segmentation/concatenation of data units includes repeating segmentation/concatenation process on retransmission data units at the input of the segmentation concatenation element and adding respective data header information.

‘106 Patent at 4-5.

Figure 6 describes the ARQ entities at the transmitter and the receiving sides (reproduced below):

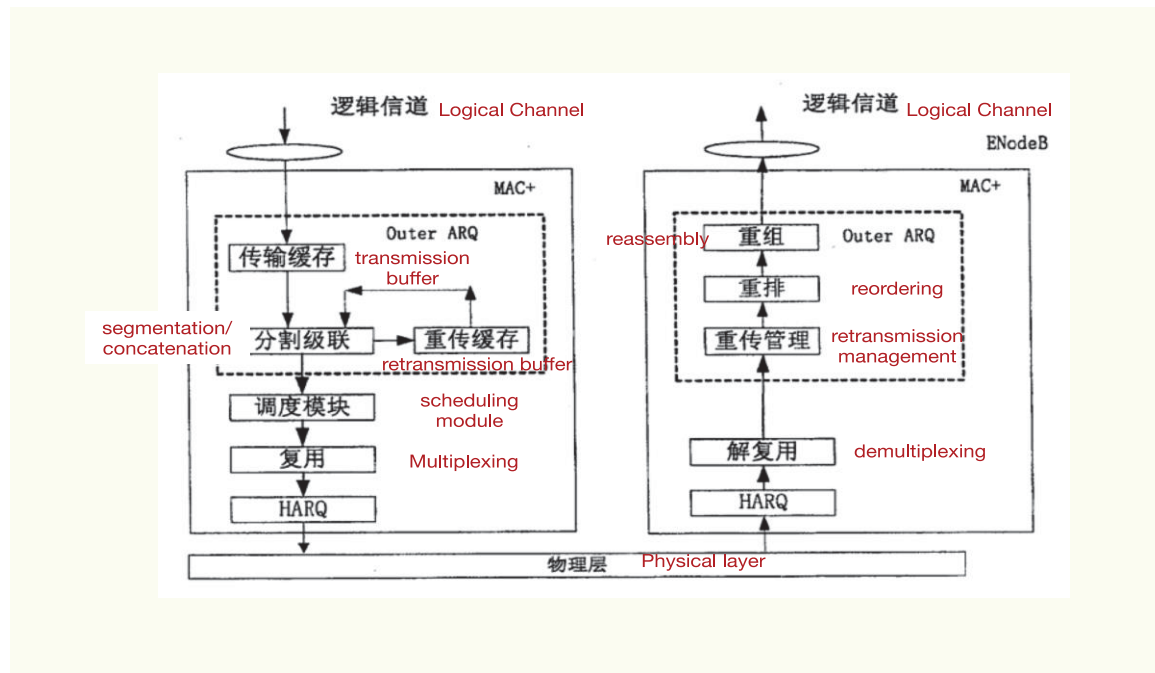


Figure 6 (the ‘106 Patent)

96. A representative independent claim (Claim 1) of the ‘106 Patent is reproduced here:

1. A radio communication network apparatus, comprising
  - (a) at least one upper layer ARQ entity;
  - (b) wherein said upper layer ARQ entity is an acknowledged mode (AM) ARQ entity, the AM ARQ entity having a transmitting part and a receiving part;

*(c) said transmitting portion further comprising (c1) segmentation concatenation element for segmentation/concateration of data unit; (c2) retransmission buffer element for buffering protocol data units (PDUs) after segmentation/concateration and for processing buffered PDUs;*

*(d) said receiving portion comprising*

*(d1) a reordering element for sorting received PDUs;*

*(d2) reassembly element for reassembling reordered PDUs into SDUs to be delivered to higher layers.*

*(e) wherein said step of segmentation/concateration of data units includes repeating the segmentation/concateration process on retransmission data units at the input of the segmentation/concateration element and adding respective data header information.*

‘106 Patent, Claim 1.

## **2. KEY ELEMENTS OF THE ‘106 PATENT’S INVENTION**

97. The ‘106 Patent summarizes that “[t]he current Release 6 (R6) standard for UMTS has some weaknesses. Notably, the RLC sublayer resides at the radio network controller (RNC) instead of the base-station (eNB) and the R6 RLC supports both AM and UM based on equal PDU size through segmentation/concateration. The receiver side support both sequential and out-of-sequence SDU delivery. In R6, AM RLC and UM RLC further established based on service needs.” ‘106 Patent at 6. The inventors of the ‘106 patent noted that:

Since RNC is removed in EUTRAN, the RLC is moved below to the basestation (eNB) and may either stand alone as an individual layer, or may be combined with

the MAC layer to form a MAC+ layer, so as to better utilize the transmission efficiency of the radio-interface air interface and reduce padding. Its segmentation/concatenation can be based on flexible PDU sizes. Furthermore, the EUTRAN system's network access is an all-IP architecture, wherein the PDCP layer is located in an access gateway (aGW). Thus, data reception must follow the order of PDCP packet transmission sequence, in order to reduce errors for the header compression in PDCP, while sequential SDU delivery by the RLC alone can no longer guarantee sequential reception by the PDCP layer. For these reasons, the characteristics of the AM and UM entities in the RLC layer of R6 can no longer meet the needs of the EUTRAN system.

See '106 Patent at 8.

98. The '106 Patent proposes a new AM entity for 3GPP EUTRAN networks. A POSITA would have been able to use its first embodiment as an example. Specifically,

The transmitting section of the AM entity at the base-station comprises: (a) a transmission buffer element, for buffering service data units (SDUs) from a logical channel; (b) a segmentation concatenation element for segmenting or concatenating SDUs in the transmission buffer to generate PDUs; (c) a retransmission buffer element to buffer segmented/concatenated PDUs for retransmission. The outer ARQ entity sends the resulting PDUs to the MAC within the station, and the station MAC scheduler schedules the PDUs to be multiplexed. The station MAC communicates with the physical channel through transport channel to implement HARQ retransmission for the multiplexed PDUs.

'106 Patent at 8.

The receiving part of the AM entity comprises: MAC in the station executes retransmission on the received physical layer PDUs when errors occur and demultiplexes retransmitted PDUs; the MAC within the station sends the demultiplexed PDUs to the retransmission management element for retransmission managing; the reordering element sorts the PDUs after retransmission management; the reassembly element reassembles the sorted PDUs to form SDUs to be sent via a logical channel for delivery to upper layers.

*Id.*

99. The inventors explicitly described some of the advantageous effects of the ‘106 invention:

By setting the transmission buffer to buffer SDUs, SDUs can be flexibly discarded according to data transmission status to improve data transmission efficiency, and can easily forward data during switchover of basestations or UEs;

By setting (default) buffer size threshold in the transmission buffer to control basestation or UE traffic control with the aGW, this invention helps prevent data loss due to basestation or UE congestion. It can also flexibly set buffer size threshold according to different scenarios to help reduce data forwarding amount, thereby avoiding data loss during switchover of basestations or UEs;

By retransmitting each data unit in the retransmission buffer, the invention avoids the retransmission of the entire data block when only partial data fails to be correctly transmitted. Also, based on the configured maximum segmentation number of the data blocks, retransmission buffer may only buffer the maximum segmented data to reduce the complexity of segmentation and reassembly;

By supporting out of sequence SDU delivery, the invention increases the processing speed of the base-station or UE, while making it possible to timely clear the respective buffer;

By pre-configuring QoS attributes of the logical channel, the invention reduces scheduling complexity, and also effectively carries out multiplexing before HARQ to avoid the performance loss as a result of multiplexing service data of different QoS attributes;

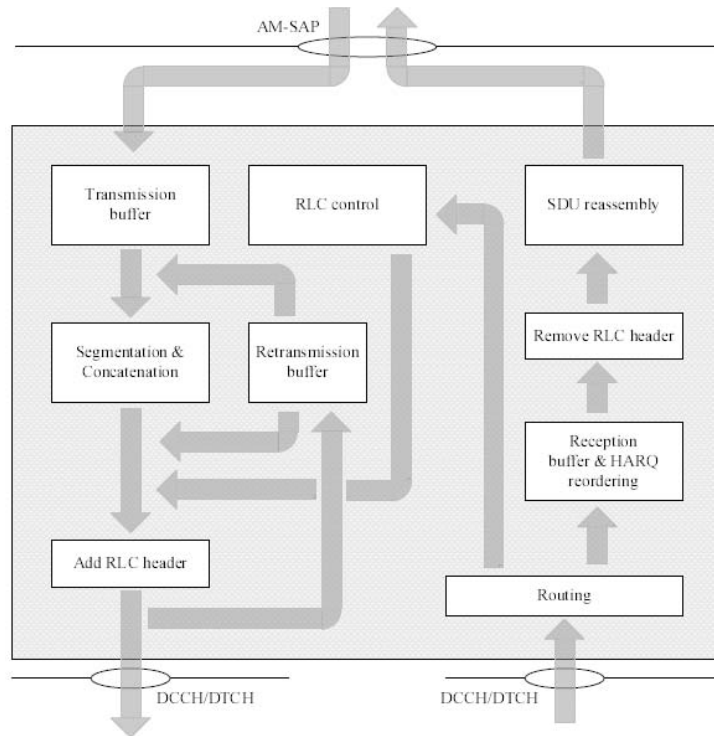
By setting the value of the sequence field based on service attributes or logical channel's QoS attributes, the invention can save the overhead of air interface.

See *Id.*

### **3. ESSENTIALITY OF THE '106 PATENT'S INVENTION**

100. Exploiting its novelties and the advantages, 3GPP has adopted the invention of the '106 Patent in its 4G-LTE standard. Specifically, Section 4.2.1.2 of 3GPP TS36.322 V13.2.0 describes the UM RLC entity. The AM RLC entity is disclosed in Section 4.2.1.3 of 3GPP TS36.322 V13.2.0, and utilizes the '106 invention as is illustrated using the following figure. The retransmission ARQ procedures of the AM RLC entity utilizes the invention of the '106 Patent and is further described in Section 5.2.1 of 3GPP TS 36.322 V13.2.0.





**Figure 4.2.1.3.1-1: Model of an acknowledged mode entity**  
3GPP TS 36.322 V13.2.0 at Fig. 4.2.1.3.1-1.

#### **4. PERSON OF ORDINARY SKILL IN THE ART (POSITA) ALTERNATIVES**

##### **a) HINDSIGHT**

101. Mr. Davies applied hindsight unavailable to a POSITA in proposing his so-called “(POSITA) alternatives.” Mr. Davies does not identify or rely upon any prior art references, or cite any evidence at all, to support his opinion that a POSITA would have known about these alleged alternatives. Mr. Davies appears to have arrived at these “(POSITA) alternatives” based purely on hindsight.

##### **b) “SMALL PDUs” IS NOT AN ALTERNATIVE**

102. Mr. Davies maintains that, instead of using flexible PDU sizes, an alternative would be to limit “the size of PDUs to very small PDUs, as if the PDUs were sufficiently small they could be segmented and concatenated without any padding, in fact it would be likely that the SDUs

would have to be segmented (broken apart) to fulfill the PDU size requirement.” Davies Rep. at ¶ 86.

103. A POSITA at the time of the filing of the ‘106 Patent would have recognized, as disclosed in the ‘106 Patent Application, that a major benefit of the cellular network evolution to EUTRAN (4G-LTE) is the substantially improved physical layer transmission rate with the adoption of OFDMA and SC-OFDM technologies. Under good physical channel conditions, the much improved EUTRAN data rates by the physical and transport channels facilitate very efficient data transmission beyond the previous R6 protocol for forming large sized PDU.

104. A POSITA would have recognized that by limiting the use of small PDUs, the high speed data transmission provided by the EUTRAN (4G-LTE) system would not be fully taken advantage of by the RLC. To be clear, “smaller PDUs” is not to improve upon the fixed PDU size of the R6, except to make the PDU size even smaller. A POSTIA would understand that smaller PDU size would reduce the relative amount of PDU payload relative to its header field, thereby further reducing the transmission efficiency of the R6 protocol, instead of improving it.

105. Mr. Davies analogizes the ‘106 Patent to a man packing his belongings to move to a new apartment, but the rental van company has only one type of vehicle available that is too large. Davies Rep. at ¶¶ 84-85. Mr. Davies acknowledges that the ‘106 Patent solved such a packing problem, and he argues that using “small PDUs” provides an alternative solution. But “small PDUs” does not. To follow the analogy used by Mr. Davies, the “small PDUs” alternative is like a person always renting a very small-sized vehicle to move his/her belongings, even though the vehicle rental company has a fleet of many different vehicle sizes, all at very low or similar prices, and even though using a small vehicle could take many trips over many days.

106. Furthermore, the suggestion of “smaller PDUs” does not address the acknowledge mode RLC, the retransmission management, retransmission buffer, and the receiver side entity in the invention. In summary, a POSITA would have recognized that the suggestion of using “smaller PDUs” fails to provide alternatives to any of the elements (a)-(e) in the representative claim (Claim 1) of the ‘106 Patent.

107. Based on at least the reasons stated above, a POSITA would not have found “smaller PDUs” to be an alternative to the inventions disclosed in the ‘106 Patent.

**c) “ORDERING” IS NOT AN ALTERNATIVE**

108. Mr. Davies suggests that an alternative to accomplish sequential delivery of SDUs to the PDCP for reducing errors during head decompression is by “having a MAC layer schedule its PDU transmissions according to the exact order.” Davies Rep. at ¶ 87.

109. A POSITA, however, would have recognized that “ordering” by the MAC layer is not a viable alternative in AM RLC because of the need for PDU acknowledgement in the AM mode to ensure that lost PDUs can be retransmitted and received. Mr. Davies’ suggestion of “having a MAC layer schedule its PDU transmission according to the exact order” cannot be accomplished because of the inevitable packet losses during the wireless transmission at the physical layer. Davies Rep. at ¶ 87. A POSITA would have recognized that, in order to achieve successful reception of the PDUs, retransmission by the transmitter side is necessary to retransmit the lost PDUs buffered in the retransmission buffer, thereby leading to out-of-sequence PDU receptions.

110. Specifically, the ‘106 Patent explicitly stated the following advantages of the invention:

By setting the transmission buffer to buffer SDUs, SDUs can be flexibly discarded according to data transmission status to improve data transmission efficiency, and can easily forward data during switchover of basestations or UEs;

By setting (default) buffer size threshold in the transmission buffer to control basestation or UE traffic control with the aGW, this invention helps prevent data loss due to basestation or UE congestion. It can also flexibly set buffer size threshold according to different scenarios to help reduce data forwarding amount, thereby avoiding data loss during switchover of basestations or UEs;

By retransmitting each data unit in the retransmission buffer, the invention avoids the retransmission of the entire data block when only partial data fails to be correctly transmitted. Also, based on the configured maximum segmentation number of the data blocks, retransmission buffer may only buffer the maximum segmented data to reduce the complexity of segmentation and reassembly;

By supporting out of sequence SDU delivery, the invention increases the processing speed of the base-station or UE, while making it possible to timely clear the respective buffer;

By pre-configuring QoS attributes of the logical channel, the invention reduces scheduling complexity, and also effectively carries out multiplexing before HARQ to avoid the performance loss as a result of multiplexing service data of different QoS attributes;

By setting the value of the sequence field based on service attributes or logical channel's QoS attributes, the invention can save the overhead of air interface.

See ‘106 Patent at 6.

111. A POSITA would have recognized that the suggestion of “ordering” does not provide any of the above advantages presented by the ‘106 Patent.

112. Furthermore, the suggestion of “ordering” fails to address the acknowledge mode RLC, the retransmission management, retransmission buffer, and the receiver side entity in the invention disclosed in the ‘106 Patent. In summary, a POSITA would have recognized that the suggestion of using “ordering” fails to provide alternatives to any of the elements (a)-(e) in the representative claim (Claim 1) of the ‘106 Patent.

113. Based on at least the reasons stated above, a POSITA would not have found “ordering” to be an alternative to the inventions disclosed in the ‘106 Patent.

## **II. TECHNICAL COMPARISON BETWEEN UNWIRED PLANET PATENTS AND ASSERTED HUAWEI AND SAMSUNG PATENTS**

114. I have been asked to opine on the technical comparability of five Unwired Planet patents (EP2229744, EP2119287, EP2485514, EP1230818, EP1105991) (collectively, “Unwired Planet Patents”), the six Huawei patents asserted in this case (U.S. Patent Nos. 8,416,892; 8,483,166; 8,644,239; 8,885,587; 8,412,197; and 8,724,613) (collectively, “Huawei Patents”), and the six Samsung patents asserted in this case (U.S. Patent Nos. RE44105; 8,619,726; 8,761,130; 8,509,350; 9,288,825; 9,113,419) (collectively, “Samsung Patents”).

115. Upon review of these patents and publicly available information about them, I have found that the Unwired Planet patents are substantially different from the Huawei Patents from a technical perspective.

### **A. UNWIRED PLANET PATENTS**

#### **1. EP2229744**

116. EP2229744 was issued to Janne Peisa, Michael Meyer, and Johan Torsner with a priority date of 2008-01-08. It belongs to a family of patents declared by the patent holder to be likely essential to TS36.322 according to the ETSI database. EP2229744 discloses a method of radio link control (RLC) polling with which a transmitting node in a communication network requests status reporting from a receiving node such that the sending node can be informed which data, if lost, should be resent. The EP2229744 Patent suggests that the RLC polling for receiver status reporting be triggered by counting the number of transmitted data units and the number of transmitted data bytes of the transmitted data units.

117. The relevant technical specification Section 5.2.2 of 3GPP TS 36.322 describes acknowledge mode (AM) RLC polling for status-reporting in the ARQ procedure. However, the disclosed technology is a counter-based trigger to send polling message for status reporting to a receiver node. By focusing on the trigger for transmitting polling message, the level of innovation for this disclosed technology is quite low. A POSITA would have recognized that there exist many alternatives such as polling triggers by a timer, transmitter buffer or channel quality.

## **2. EP2119287**

118. EP 2119287 was issued to Johan Moe and Harald Kallin with a priority date of 2007-02-28. It belongs to a family of patents declared by the patent holder to be likely essential to 3GPP Technical Specification 3GPP TS 36.331 (4G-LTE) according to the ETSI database. The patent discloses a method for a mobile UE in a multi-cell wireless telecommunications system to receive an instruction from the BS of a first cell to detect a unique cell identifier information for a second cell upon receipt of the instruction, and report the detected unique cell identifier information for the second cell to the BS of the first communications cell.

119. The relevant technical specification Section 5.5 of 3GPP TS 36.331 describes the Intra-LTE/frequency Automatic Neighbour Relation (ANR) function of the eNB in the serving cell. As a part of the normal call procedure, the eNB instructs each UE to perform measurements on neighbour cells. When a UE sends a measurement report regarding another cell (cell B), the report contains Cell B's physical cell identifier (PCI) which is non-unique, but not its E-UTRAN Cell Global Identifier (ECGI), which is unique. When cell A's eNB receives a UE measurement report containing the PCI of cell B, the eNB instructs the UE, using the newly discovered PCI as parameter, to read the ECGI of the neighbour cell B and report the ECGI.

120. The relevant technical specification Section 5.5 of 3gPP TS 36.331 describes the Intra-LTE/frequency Automatic Neighbour Relation (ANR) function of the eNB in the serving cell. The disclosed technology is for eNB to send an instruction that a UE must follow during reporting. By focusing on letting UE obey such an instruction, the level of innovation is quite low. A POSITA would have recognized other practical alternatives such as reporting ECGIs of neighbor cells whose signal strengths exceed a preset threshold.

### **3. EP2485514**

121. EP2485514 was issued to Johan Moe and Harald Kallin with a priority date of 2007-02-28. It belongs to the same family of patents as EP2119287 discussed above and discloses the same technology.

### **4. EP1230818**

122. EP1230818 was issued to Ola Richard Svensson with priority date of 1999-11-17. It belongs to a family of patents that is declared to be essential to 3GPP TS 45.008 according to the ETSI database. It discloses a method for autonomously reporting measurement information from a mobile terminal active in a first wireless system to another (a second) communication

system or network. The terminal takes downlink measurement of the first system from a base-station. The measurement information reporting method begins at the terminal by first converting a plurality of downlink measurement values associated with the first said communication system to a plurality of downlink measurement values defined in the said second communication system. After comparing said converted plurality of downlink measurement values with at least one threshold value, the measurement report to the second system is triggered if at least one of said converted measurement values exceeds a predetermined threshold value. The terminal then sends at least one of the converted downlink measurement values on a control channel to a control node in said second communication system. This disclosed method may allow a terminal to update its connectivity from one connection protocol to another connection protocol when the measurement meets a pre-determined condition. If the measured channel condition is sufficient for a UE to connect from a 2G network (GSM) to a 3G network (UMTS) when associated with the same base-station, the method triggers UE measurement report to a control node. The patent described that, “[f]or example, Universal Mobile Telecommunication System (UMTS) measurement information can be conveyed from a mobile terminal (22) to a Base Station Controller (BSC) (14) in a Global System for Mobile Communications (GSM network.” EP1230818 at Abstract.

123. The relevant technical specification Section 6.6.4 and Section 10.1.1.3 of 3GPP TS 45.008 (GSM, 2G) describes measurement of a UE in the 2G (GSM) network on cells of other radio access technologies such as 3G (UMTS). The disclosed technology is for a UE to perform reporting of converted measurement triggered by a measurement value exceeding a set threshold. By focusing on a threshold-triggered conversion and reporting, the level of innovation of this disclosed technology is low. A POSITA would have recognized other practical alternatives such



as reporting measurement be triggered when the current network speed is too slow or when the buffer of the current connection is too large.

## **5. EP1105991**

124. EP1105991 was issued to Johan Nystrom and Branislav Popovic with priority date of 1998-8-17. It belongs to a family of patents that is declared to be essential to UMTS according to the ETSI database.

125. For a communication system such as the 3G UMTS cellular network using direct-sequence code division multiple access (DS-CDMA), finding the timing reference corresponds to finding the timing boundaries of downlink chips, symbols, and frames of the BS transmission. This search of BS timing is called “cell search,” and it includes identification of BS-specific downlink scrambling codes used in UMTS (3G cellular). The slot and frame boundaries in the received signal are unknown to the MS to begin with, as are any BS-specific scrambling codes. The goal of the MS is thus to detect and identify one or more BSs in the received signal and to identify the scrambling code used. In UMTS, the scrambling codes are divided into 512 groups of 1 primary code and 15 secondary codes. EP1105991 discloses a method for detecting the scrambling code group of a received signal in a communication system.

126. The relevant technical specification Section 5.2.2 of 3GPP TS 25.213 (UMTS, 3G) describes the scrambling codes are divided into 512 groups of 1 primary code and 15 secondary codes to facilitate cell search in UMTS. The disclosed technology is for a UE to perform the detection of received scrambling code group using correlation by utilizing the scrambling code’s characteristics already defined by 3GPP TS 25.213. By disclosing on ways to utilize the scrambling codes’ characteristics during detection, the level of innovation of this disclosed technology is low. A POSITA would have recognized other practical alternatives of detection

exists, such as non-coherently superimposing the magnitudes of correlations, or the sum energy of the correlation signals, in accordance with cyclic shifts of each of a plurality of sequences of signs, instead of applying coherent combination, for determining a maximal coherently combined correlation to identify the scrambling code group for the received signal.

## **B. HUAWEI PATENTS**

### **1. US8416892**

127. US 8,416,892 was issued to Oskar Mauritz, with a priority date of 2007-04-30. It belongs to a family of patents that is declared to be essential to 3GPP Technical specifications TS 36.211 (4G-LTE) according to the ETSI database. There are 64 preambles in each cell defined in 3GPP TS 36.211 v14.2.0.

128. When initiating a random access procedure, a mobile terminal transmits one of the 64 preambles. A message is transmitted to a base station by the mobile terminal selecting a particular preamble. This invention requires that a random access preamble be selected from a subset of random access preambles; wherein the subset of random access preambles is provided with Zero Correlation Zones of length  $N_{cs}-1$ , where  $N_{cs}$  is a cyclic shift increment selected from a pre-defined set of cyclic shift increments and the pre-defined set includes all of the following cyclic shift increments of 0, 13, 15, 18, 22, 26, 32, 38, 46, 59, 76, 93, 119, 167, 279, 419. These are specified in 3GPP TS 36.211 v14.2.0 in Table 5.7.2-2: NCS for preamble generation (preamble formats 0-3).

129. Random access is the initial phase of a UE connection when attempting to connect to the cellular network. The invention provides better random preamble sequences with nice correlation properties in a subset which shall be used in the random access to reduce interference by lowering correlations. The innovation level of this invention is superior to typical inventions

declared to ETSI. None of the Unwired Planet Patents relates to similar technology, or reflects as high a level of innovation, as the '892 Patent.

## **2. US8483166**

130. US 8,483,166 was issued to Xiaolong Guo, with a priority date of 2007-11-01. It belong to a family of patents declared to be essential to 3GPP Technical specifications TS 33.401 (2G, 3G, 4G), TS 23.003 (2G, 3G), and TS 36.401 (4G-LTE) according to the ETSI database.

131. This invention relates to a solution that allows a UE to efficiently switch from an LTE network to access a legacy network. In the solution of the '166 patent, the UE places information from a temporary ID of an LTE network (GUTI) in an access message sent to a newly selected core network node (SGSN) in a legacy network. The newly selected SGSN can then use this information from the GUTI to obtain the context of a UE from the previously-assigned core network node (MME) in the LTE network. Cell reselection in areas where only legacy coverage exists would require a UE to be switched to a different MME for mobility management in the newly selected legacy network. The level of innovation is superior and tackles multiple levels of challenges, including security, MME identity, and user identity, that concern UE confidentiality. None of the Unwired Planet Patents relates to similar technology, or reflects as high a level of innovation, as the '166 Patent.

## **3. US8644239**

132. US 8,644,239 was issued to Bingyu Qu, Yajuan He, and Xuan Feng, with a priority date of 2007-03-07. It belongs to a family of patents that is declared to be essential to 3GPP Technical specifications TS 36.211 (4G-LTE) according to the ETSI database. There are 64 preambles in each cell defined in 3GPP TS 36.211 v14.2.0.

133. This patent relates to the use of CAZAC sequences. In communication systems, the Constant Amplitude Zero Auto-Correlation (CAZAC) sequence is a very important communication resource. CAZAC sequence is typically used for synchronization, preamble, and channel estimation by the receiving units based on the nice autocorrelation property of the sequence. This invention provides ways to design better sequences from CAZAC such that multiple cells may select its own CAZAC that has lower correlation and mutual interference with other cells during the channel estimation process.

134. Sounding reference signals and uplink DMRS sequences are highly important for the eNodeB to estimate the channel quality of the UE uplink. Based on this information, the cellular network can provide good uplink resource allocation *and* perform uplink signal detection (based on DMRS) for data reception. Groups of sequences are studied and proposed for use in cellular uplink UE signaling of SRS and DMRS that is critical to maintaining strong network links and high efficiency. The proposed solution leads to more accurate channel estimation, as a result of lowering interferences from multiple transmitting UEs. The proposed solution improves channel estimation accuracy and is very important to the network. The innovation level of this work is exceptional. None of the Unwired Planet Patents relates to similar technology, or reflects as high a level of innovation, as the '239 Patent..

#### **4. US8885587**

135. US 8,885,587 was issued to Xiaobo Chen and Chaojun Li, with a priority date of 2009-12-03. It belongs to a family of patents that is declared to be essential to 3GPP Technical specifications TS 36.212 and TS 36.231 of 4G-LTE according to the ETSI database.

136. This patent relates to innovative ACK/NACK feedback implementations for enabling high rate carrier aggregation link. The invention enables a UE to receive data from

primary and secondary downlink component carriers, and efficiently feedback ACK/NACK information on a primary uplink component carrier. The invention uses a transmission power control (TPC) command as a common field within downlink control information. When a piece of downlink control information (DCI) is received from the primary downlink component carrier, which is system-linked with the primary uplink component carrier, the TPC command indicates transmission power control information for all ACK/NACK sent on the primary uplink component carrier. And when the piece of DCI is received from a secondary downlink component carrier (not system-linked with the primary uplink component carrier), the TPC command indicates an acknowledgement resource indicator for scheduling ACK/NACK feedback on the primary uplink component carrier.

137. Carrier aggregation is an important technology to allow higher bandwidth to be allocated to one UE to achieve higher data rates. The control channel information would be better handled by a single component carrier. By providing a compatible solution to accommodate such control channel information, the level of innovation is superior to typical inventions declared to ETSI. None of the Unwired Planet Patents relates to similar technology, or reflects as high a level of innovation, as the '587 Patent.

## **5. US8412197**

138. US 8,412,197 was issued to Michael Roberts, Johan Johansson, Boyun XiE, and Min Huang, with a priority date of 2008-04-09. It belongs to a family of patents that is declared to be essential to 3GPP Technical specifications TS 25.331 (UMTS), TS 25.304 (UMTS), TS 36.331 (4G-LTE), and TS 36.304 (4G-LTE) according to the ETSI database.

139. The US 8,412,197 Patent discloses a priority-based cell reselection method to reduce the measurements by the terminal and save power energy, and possibly lead to better load

balance. In previous technical solutions, the terminal performs cell reselection in a non-LTE network by using a dedicated priority list established by the non-LTE mobile communication system. The Access Network (AN) node or the Core Network (CN) node has to add more signaling for establishment of the dedicated priorities, which leads to higher costs for network upgrade. The disclosed invention of this patent for reselection allows a dedicated priority list with valid time be established for an UE in an E-UTRAN network that is also applied when currently not on E-UTRAN network. The dedicated priority list is delivered in dedicated signaling of the LTE system with a valid time parameter. Within the valid time, the terminal will attempt to reselect a cell of the LTE system only when the signal quality of the current cell decreases to a certain level. The valid time and dedicated priority list may be delivered to the terminal by eNB via a RRC dedicated signaling in a Non-Access Stratum (NAS) message to the terminal by a CN node. Before the timer expires, the terminal camps on a cell which has the highest priority shown in the dedicated priority list. The terminal decides whether to perform cell reselection according to signal quality of the current cell. When the signal quality of the cell decreases to a preset threshold, the terminal may perform cell reselection according to the dedicated priorities and the valid time. Next, when the dedicated priority list is invalid, the terminal stops using the dedicated priority list and deletes the dedicated priority list. The terminal then uses the public priority list for cell reselection.

140. Cell reselection is critical in mobile wireless communication networks. The innovation of this patent's reselection allows a dedicated priority list with valid time be established for an UE in an E-UTRAN network that is also applied when currently not on E-UTRAN network. The solution reduces the measurements by the terminal and saves power or energy. Another advantage of a priority list may be to actively perform load balancing among cells. The innovation

level of this invention is superior. None of the Unwired Planet Patents relates to similar technology, or reflects as high a level of innovation, as the '197 Patent.

**6. US8724613**

141. US 8,724,613 was issued to Junwei Wang, Xiaolan Fan, and Jianghua Liu, with a priority date of 2007-02-12. It belongs to a family of patents that is declared to be essential to 3GPP Technical specifications TS 25.300 and TS 36.321 of 4G-LTE according to the ETSI database.

142. This particular part of the standard consists of the MBSFN provision and discussion in cellular systems. Multicast broadcast multimedia services do contribute significantly to the user experience and value of cellular networks.

143. The invention corresponds to the standard in that there is a unique pattern of frames and subframes specific to a MBSFN area, which are used to transmit services such as MBMS. The invention solves the problem of how to efficiently signal to the UEs the MBSFN position of the frames and subframes, which saves battery life of the UE and improves network efficiency. The innovation level of this invention is typical. None of the Unwired Planet Patents relates to similar technology.

**C. SAMSUNG PATENTS**

144. I have reviewed Mr. Davies' opinions regarding the "technical similarities between the Unwired Planet and Samsung Patents" in paragraphs 88 to 99 of his report.

145. In my opinion, Mr. Davies does not provide a sufficient basis to conclude that the Unwired Planet Patents and Samsung Patents are technically comparable.

146. Mr. Davies does not provide any analysis in his report regarding technical comparability and innovation, other than broadly stating that both the Unwired Planet Patents and

Samsung Patents “relate” to the LTE standard and that all of the patents are somehow novel and valuable. *See* Davies Rep. at ¶ 89. Mr. Davies only provides a one-sentence description of each patent that is insufficient to establish whether and how each patent “relates” to LTE.

147. Mr. Davies does not opine that the patents cover related technical subject matter. In fact, Mr. Davies suggests that the patents do not cover related technical subject matter, by stating that “each patent relates to a different aspect or subsystem of the LTE standard.” *See Id.*

148. Mr. Davies provides no explanation of the novel features of each patent, and no explanation of the benefits of the patent. Mr. Davies does not assess or compare the quality of the Unwired Planet Patents or the Samsung Patents.

149. Due to lack of analysis in Mr. Davies’ report, his conclusions about the technical similarities between the Unwired Planet Patents and Samsung Patents lack a sufficient basis and technical justification.

**D. SUMMARY OF FINDINGS**

150. To summarize, the Unwired Planet Patents are not technically comparable to the Huawei Patents. The Unwired Planet Patents do not relate to similar technology as the Huawei Patents, the Unwired Planet Patents display a much lower level of innovation, and a POSITA would have recognized viable alternatives to each of the Unwired Planet Patents. Mr. Davies does not provide a sufficient basis to conclude that the Unwired Planet Patents are technically comparable to the Samsung Patents.

Executed on this 25 day of May, 2018, in Davis, California.

By

  
Dr. Zhi Ding



## **Appendix A**

## Expert/Consultant Curriculum Vitae

### Professor Zhi Ding

Ph.D. and Fellow of IEEE

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#### Expertise

- |                                  |                                  |
|----------------------------------|----------------------------------|
| ▪ Wireless Communication Systems | ▪ Digital Transmissions          |
| ▪ Cellular Wireless              | ▪ DSL and Cable Internet Service |
| ▪ Communication networks         | ▪ Digital Signal Processing      |
| ▪ Signal Processing and Analysis | ▪ WiFi, LTE, DOCSIS, Bluetooth   |
- 

#### Professional Summary

- *Professor of major US universities for over 27 years.*
- *Consulted for major engineering companies such as Nortel, Analog Devices, Intel, and NEC*
- *Worked as expert on multiple patent infringement cases.*
- *Conducted research works on Communications and Signal Processing for over 30 years.*
- *Supervised over 25 PhD students.*
- *Author of more than 170 journal papers and 2 books on communication technologies.*

Dr. Zhi Ding has been a professor of electrical engineering at major US universities for 27 years. Since 1995, he has consulted for both engineering companies such as Nortel, Analog Devices, Intel, and worked as expert for major law firms such as Kirkland & Ellis, WilmerHale, Quin Emanuel, Fish & Richardson, on multiple technical and patent infringement cases. He has been conducting research works on wireless communications and signal processing since 1984. He has supervised over 25 PhD students. He is an author of 170 journal papers and 2 technical books on communication technologies. He has taught classes that cover the fundamentals of signal detection, communications, and systems.

Dr. Ding was appointed as the Child Family Professor of Engineering and Entrepreneurship in 2009-2014. He served as the steering committee chair of the IEEE Transactions on Wireless Communications. He was elevated to Fellow of IEEE in 2002 by the IEEE Signal Processing Society. He also served as the Technical Program Chair of the IEEE Globecom 2006 (the flagship conference of the IEEE Communications Society), Dr. Ding is an eminent scholar and expert of wireless technologies AND signal processing.

## Expert/Consultant Curriculum Vitae

### Consulting History (Partial List):

#### Past Client

Kirkland & Ellis LLP

#### Past Services

Expert consultant on various wireless (cellular and WiFi) and communications technologies since 2007. Major engagements include

2007-10: E. D. Texas, C.A. No. 2:07-CV-474

2008-10: E. D. Texas, C.A. No. 2:08-CV-247

2008: Apple License Consulting (M. Pieja)

2009: Apple Patent Analysis (B. Kwok)

2009: Cisco v. MOSAID matter (E. Lamison)

2009-10: D. Del. C.A. No. 07-CV-752

2008-10: D. Del. C.A. No. 07-md1848

2009-10: E.D. Texas, C.A. No. 5:09-cv-00101

2010-13: Netgear, Inc. & Ruckus Wireless Inc. Patent Matter, Netgear, Inc. & Ericsson Inc. Patent Matter. (E. Lamison)

2011-13: E. D. Texas, C.A. No. 6:10-cv-00473-LED

2011-13: N. D. Illinois, No. 1:11-cv-09308

2011-13: D. Del. Case No. 1:11-cv-00425

2013: Alcatel-Lucent Patent matters (B. Nguyen)

Wilmer Cutler

Pickering Hale, and  
Dorr, LLP

Expert consultant on cellular wireless and communications technologies since 2010. Major engagements include

2009-11: D. Del. C.A. No. 09-791-GMS

2009-11: D. Del. C.A. No. 09-1002 and ITC Docket 2702

2011-13: Apple Inc. v. Samsung Electronics Co. (US, Japan, Korea, Germany, the Netherlands, UK, Italy, and others) including N. D. Cal, Case No. 11-cv-01846, ITC Docket Nos. 2824, 2827.

Fish and Richardson,  
LLP

Expert witness on cellular wireless and communications technologies for Marvell, Inc. Major engagements include

2014-15: *Inter Partes* Review of U.S. Patent 5,712,870

2014: *Inter Partes* Review of U.S. Patent 6,977,944

Kaye Scholer LLP

US District Court of Delaware

2009-10: D. Del. C.A. No. 07-CV-752

2008-10: D. Del. C.A. No. 07-md1848

Representing defendant as expert technical consultant against infringement accusations involving data over cable services. Case dropped by the plaintiff after expert reports 2008-2009. Attorney's fees recovered.

2012: C.D. Cal., CV 11-09373 RGK (RZx)

2012: D. Del., C.A. No. 10-1062-GMS

Bridges and  
Mavrakakis, LLP

IP Evaluation matters regarding client multi-billion dollar Patent portfolio purchase and other matters since 2011.

## Expert/Consultant Curriculum Vitae

Sterne, Kessler, Goldstein & Fox PLLC	Technical consultant and expert declarant in Inter Partes Review Proceedings US Patents 7,477,624, 7,903,608, 8,542,643.
Bramson, Plutzik, Mahler & Birkhaeuser	2013: Expert witness for Plaintiff for a putative class action.
Gibson, Dunn & Crutcher, LLP	2014: Expert Consultant, for AT&T Mobility LLC and Cricket Communications, Inc., D. Del. Civil Action Nos. 13-1668 (LPS) 13-1669 (LPS)
Quinn Emanuel	2014: Expert technical consultant in Civil Action No. 1:13- cv-473 (D. Del.) (SLR)
Norton Rose Fulbright US LLP	2015-17: Technical consultant and expert witness in 1:14- cv-00436 (D. C. West Texas) and IPR2015-10577, IPR2015-10580, IPR-201510581.
Sheppard, Mullin, Richter, and Hampton, LLP	2015-17: Technical consultant and testifying witness in Case No. 8:14-cv-341 (C. D. CA).
Rothwell, Figg, Ernest, and Manbeck, P.C.	2016: Technical consultant and expert witness in 15-cv- 01746-H-RBB (S. D. CA).
Mayer Brown LLP	
Sidley Austin, LLP	2016-17: Technical consultant and expert testifying witness in Arbitration on SEP and licensing disputes.
Irell & Manella, LLP	2016-17: Technical consultant and expert testifying witness on SEP and licensing disputes.
Venable, LLP	2016-17: Technical consultant and testifying witness regarding US Patent disputes.
	2017-18: Expert witness for Verizon Services Corp. in Case No. 2:16-CV-588-WCB (E. D. TX) on US Patent disputes.

## Expert Witness/Deposition

## Expert/Consultant Curriculum Vitae

### Past Client

Bramson, Plutzik,  
Mahler &  
Birkhaeuser LLP

### Past Services

2013: Deposition on Case No. CV 12-05240 PJH  
Nad Karim v. Hewlett Packard, Co.  
UNITED STATES NORTHERN DISTRICT COURT OF  
CALIFORNIA. Settlement ordered Jan. 18, 2017.

Fish and Richardson  
(Representing  
Marvell)

2015 (Feb. & August): 2 Depositions for Marvell.  
US PTAB *Inter Partes* Review IPR2014-00548  
Marvell Semiconductor, Inc. v. Intellectual Ventures I LLC

Norton, Rose,  
Fulbright, US, LLP

2016 (April): Deposition for  
US PTAB *Inter Partes* Review IPR2015-10577, IPR2015-  
10580, IPR2015-10581, IPR2015-10581.  
Qualcomm Inc. v Bandspeed Inc.

Sheppard, Mullin,  
Richter, and  
Hampton, LLP

2016 (May): Deposition for TCL in  
*TCL Communication Technology Holdings, LTD., et al. v.*  
*Ericsson, et al.*, Case No. 8:14-cv-341 (C. D. CA).  
2017 (Feb): Testified during court proceeding for TCL.

Sidley Austin, LLP

2016 (December): Testified for Huawei in  
Huawei Technologies, Co. Ltd v. Samsung  
Regarding FRAND licensing disputes in Shenzhen Court, P.R.  
China.

Mayer Brown LLP

2017 (January): Testified during tribunal proceeding for  
LG Electronics, Inc. in standard essential patent (SEP) licensing  
dispute of  
Nokia Technologies, Ltd. v. LG Electronics, Inc.  
During arbitration hearing in Paris, France.

Venable LLP

2017 (October): Deposition as expert witness for Verizon  
Services Corp. in Case No. 2:16-CV-588-WCB (E. D. TX) on  
US Patent disputes.

## Employment History

From: 2000      **University of California at Davis**  
To: Present      Davis, CA  
Position: *Professor, Department of Electrical and Computer Engineering*

## **Expert/Consultant Curriculum Vitae**

From: 01/1999 **University of Iowa**  
To: 09/2000 Iowa City, IA  
Position: *Assoc. Professor, Department of Electrical and Computer Engineering*

From: 01/1997 **Hong Kong University of Science and Technology**  
To: 12/1997 Hong Kong  
Position: *Visiting Associate Professor, Department of Electrical and Electronic Engineering*

From: 09/1995 **Auburn University**  
To: 12/1998 Auburn, AL  
Position: *09/1995-12/1998: Associate Professor, Department of Electrical and Computer Engineering*  
*09/1990-08/1995: Assistant Professor, Department of Electrical and Computer Engineering*

From: 08/1993 **Australian National University**  
To: 09/1993 Canberra, Australia  
Position: *Visiting Research Fellow, Faculty of Information Technology and Engineering*

From: 06/1993 **US Air Force Wright Laboratory**  
To: 08/1993 Eglin AFB, Florida  
Position: *Faculty Research Associate, Armament Directorate*

From: 06/1992 **NASA Lewis Research Center**  
To: 08/1992 Cleveland, OH  
Position: *Visiting Faculty Research Fellow*

From: 08/1987 **Cornell University**  
To: 08/1990 Ithaca, NY  
Position: *Research Assistant*

From: 09/1984 **University of Toronto**  
To: 08/1987 Toronto, Ontario, Canada  
Position: *Research Assistant*

## Expert/Consultant Curriculum Vitae

### Patents (Granted and/or Licensed)

<u>Patent Number</u>	<u>Date Issued</u>	<u>Title</u>
US 6,396,885	Mar.28, 2002	Co-channel interference reduction in wireless communications systems (Nortel)
US 6,463,099	Oct.8, 2002	Blind channel equalizers and methods of blind channel equalization (Licensed)
US 7,379,513	Mar. 20, 2008	Channel estimation in CDMA communications systems using both lower power pilot channel and higher power data channel

### Education

1990	Cornell University, Ithaca, NY	Ph.D., Electrical Engineering
1987	University of Toronto, Toronto, Canada	MS, Electrical Engineering
1982	Nanjing Institute of Technology, Nanjing, China	BS, Wireless Engineering

### Publications

#### Books & Book Chapters

- [1] B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4<sup>th</sup> edition, Oxford University Press, 2009 (in Press).
- [2] Zhi Ding and Ye Li, *Blind Equalization and Identification*, Marcel Dekker, New York, 2001.
- [3] Z. Ding, "Chapter 7: Linear Predictive Algorithms for Blind Multichannel Identification," in *Signal Processing Advances in Wireless and Mobile Communications*, Vol. I: Trends in Channel Estimation and Equalization, G. B. Giannakis, Y. Hua, P. Stoica, and L. Tong (Editors), Prentice Hall, 2000.
- [4] Z. Ding, "Blind Channel Identification and Equalization using Spectral Correlation Measurements: Frequency Domain Analysis," in *Cyclostationarity in Communications and Signal Processing*, William A. Gardner, Ed., pp.417-436, IEEE Press, 1993.
- [5] Z. Ding, C. R. Johnson, Jr., and R. A. Kennedy, "Chapter 3: Global Convergence Issues with Linear Blind Adaptive Equalizers," in *Blind Deconvolution*, Simon Haykin, Ed., pp.60-120, Prentice-Hall, 1994.
- [6] Z. Ding, "Adaptive Filters for Blind Equalization," in *IEEE DSP Handbook*, Douglas B. Williams, Ed., pp.24.1-24.17, IEEE Press, 1998.

#### Journal Papers

- [1] W. Wu and Z. Ding, "[On Efficient Packet-Switched Wireless Networking: A Markovian Approach to Trans-layer Design and Optimization of ROHC](#)," in *IEEE Transactions on Wireless Communications*, vol.17, no.9, pp.1-1 doi: 10.1109/TWC.2017.2694840
- [2] W. Wu, H. Mittelmann, and Z. Ding, "[Modulation Design for MIMO-CoMP HARQ](#)," *IEEE Communications Letters*, vol.21, no.2, pp.290-293, Feb. 2017. doi:

## Expert/Consultant Curriculum Vitae

10.1109/LCOMM.2016.2618796

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- [4] X. Liang; M. Yuan; J. Wang; Z. Ding; M. Jiang; C. Zhao, "Constellation Design Enhancement for Color-Shift Keying Modulation of Quadrichromatic LEDs in Visible Light Communications," *Journal of Lightwave Technology*, vol.PP, no.99, pp.1-1, 2017. doi: 10.1109/JLT.2017.2720579
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- [11] Chen Sun, Xiqi Gao, and Zhi Ding, "BDMA in Multi-Cell Massive MIMO Communications: Power Allocation Algorithms," *IEEE Transactions on Signal Processing*, vol. 65, No. 11, pp. 2962-74, June 2017.
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## Expert/Consultant Curriculum Vitae

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- [16] D. Qin and Z. Ding, "[Exploiting Multi-Antenna Non-Reciprocal Channels for Shared Secret Key Generation](#)," in *IEEE Transactions on Information Forensics and Security*, vol. 11, no. 12, pp. 2693-2705, Dec. 2016. doi: 10.1109/TIFS.2016.2594143
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## Expert/Consultant Curriculum Vitae

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## Expert/Consultant Curriculum Vitae

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### Professional Services and Achievements

- Steering Committee Chairman, *IEEE Transactions on Wireless Communications*, 1.2008-1-2010
  - Canadian National Science and Engineering Research Council Panelist, 2009-2012
  - Fellow of IEEE
  - Steering Committee Member, *IEEE Transactions on Wireless Communications*, 1.2006-1-2008
  - General Chair, IEEE 2016 International Conference on Acoustics, Speech, and Signal Processing, Shanghai, China.
  - Technical Program Chair, *IEEE 2006 Globecom*, San Francisco, CA.
  - Editorial Board Member, *IEEE Signal Processing Magazine*, 1/2003-1/2007.
  - Associate Editor, *IEEE Signal Processing Letters*, 1.2002-1.2005.
  - Associate Editor, *IEEE Transactions on Signal Processing*, 1.2001-1.2004.
  - Editor, Special Issue on Multiuser Detection and Blind Estimation, *EURASIP Journal on Applied Signal Processing*, Dec. 2002.
  - Member, IEEE Statistical Signal and Array Processing Technical Committee, 1993-1998.
  - Member, IEEE Signal Processing for Communications Technical Committee, 1998-2004.
  - Associate Editor, *IEEE Transactions on Signal Processing*, 1994-1997.
  - Technical Program Committee Member, 3rd IEEE Workshop on Signal Processing Advances in Wireless Communications, Taiwan, March 2001.
  - Organization Committee Member, 1st IEEE Workshop on Signal Processing Advances in Wireless Communications, Paris, France, April 1997.
  - Review Panelist, National Science Foundation, 1997, 2003, 2004, 2005, 2007, 2008, 2010, 2014, 2015, 2016.
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## **Appendix B**

## Appendix B

### Materials Considered

#### Document Productions:

<b>PRODBEG</b>	<b>PRODEND</b>
HW Samsung 00095619	HW Samsung 00095630
HW Samsung 00113804	HW Samsung 00113822
HW Samsung 00119046	HW Samsung 00119065
HW Samsung 00120556	HW Samsung 00120574
HW Samsung 00122730	HW Samsung 00122740
HW Samsung 00388341	HW Samsung 00388361
SAMSUNG-HNDCA-000000280	SAMSUNG-HNDCA-000000299
SAMSUNG-HNDCA-000000300	SAMSUNG-HNDCA-000000323
SAMSUNG-HNDCA-000000346	SAMSUNG-HNDCA-000000361
SAMSUNG-HNDCA-000000388	SAMSUNG-HNDCA-000000408
SAMSUNG-HNDCA-000000409	SAMSUNG-HNDCA-000000430
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#### Other:

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- US Patent Application Publication No. 2009/0303956 A1 (2009-12-10)
- US Patent Application Publication No. 2010/0322114 A1 (2010-12-23)
- US Patent Application Publication No. 2011/0242997 A1 (2011-10-06)
- US Patent Application Publication No. 2013/0028192 A1 (2013-01-31)